THE TECH ENGINEERING NEWS

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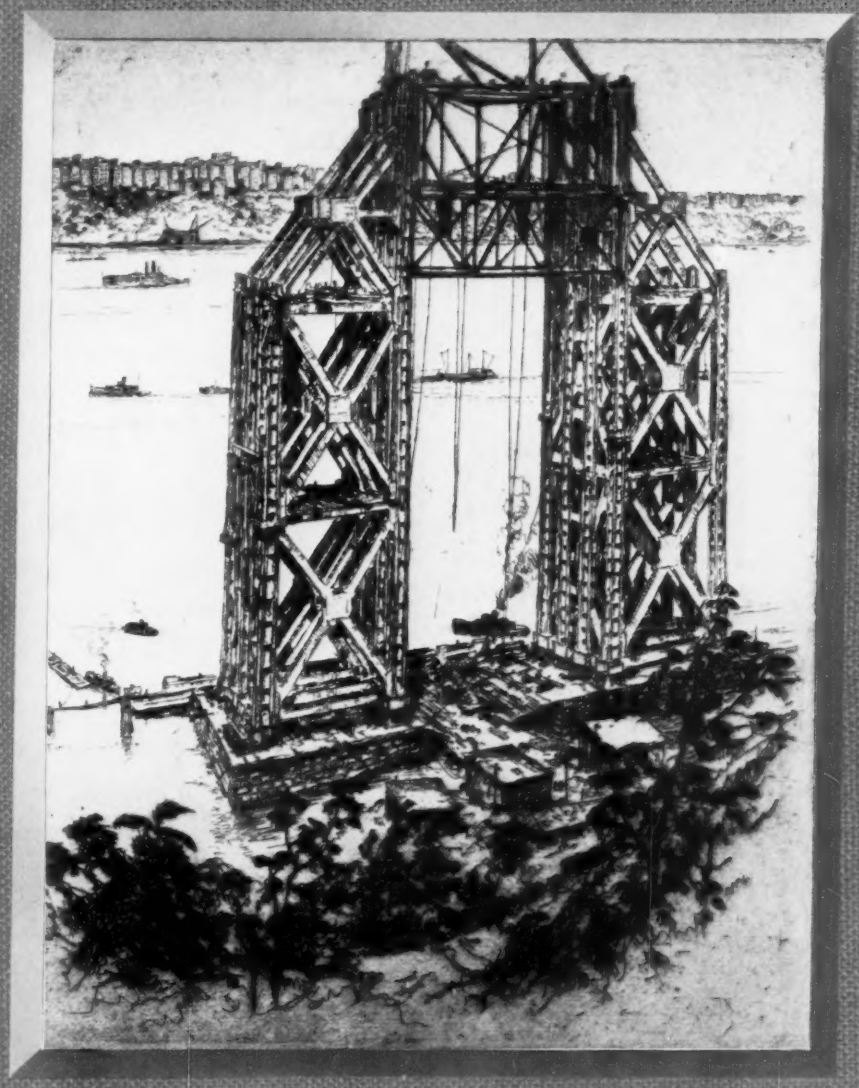

MASSACHUSETTS
INSTITUTE OF
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VOLUME X, NO. 2
MARCH, 1929

800,000 pounds of STEAM per hour from one unit!

N. Y. Times, Dec. 1928

NEW YORK EDISON BUYS 3 RECORD-SIZE BOILERS

Will Drive Largest Single-Unit Generating Machine in World at East 14th St. Plant.

Matthew S. Sloan, president of the New York Edison and associated companies, announced yesterday the closing of a contract with the International Combustion Engineering Company for three boilers that will be the largest ever built. Each will be about as high as an average eight-story building. They are to be installed in the East River generating station of the New York Edison Company at Fourteenth Street and will supply steam to drive the largest single-shaft, single-unit electric generating machine in the world, a 150,000 kilowatt turbo-generator now being built by the General Electric Company.

* * *

The over-all height of the new boilers, which are of the Double Ladd type with fin tube water walls, will be 95 feet, with furnaces 23 feet wide and extending back 65 feet. Each will supply a maximum of 800,000 pounds of steam an hour at a temperature of 700 degrees Fahrenheit, at 425 pounds a square inch pressure. The heighth of the boilers is approximately that of an eight-story building, allowing twelve feet for each floor.

With a heating surface of 60,000 square feet each, the compactness of the battery of boilers will make them not only the greatest producers of steam in the world but also the most economical for the space occupied and the coal consumed. Each of the boilers will require 80,000 pounds of coal an hour, or nearly 1,000 tons daily, if operated continuously at that rate.

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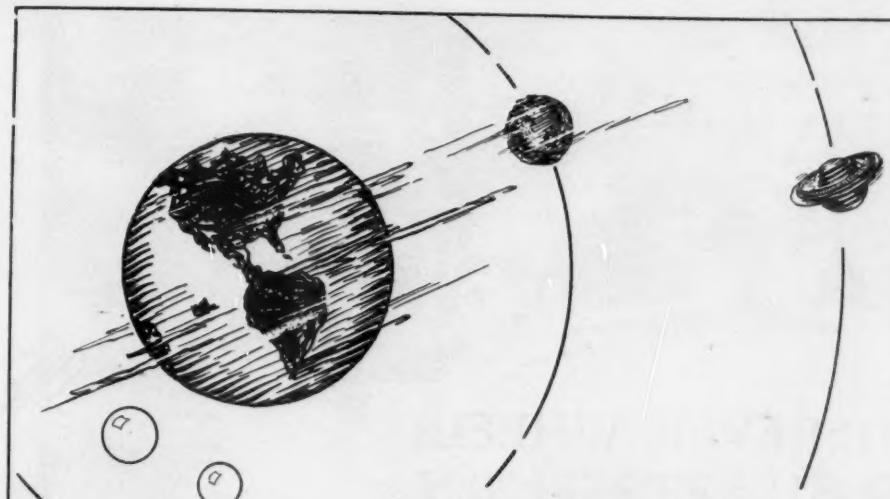

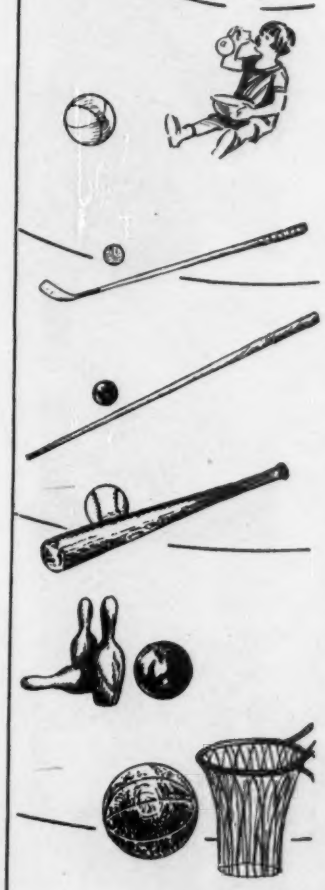

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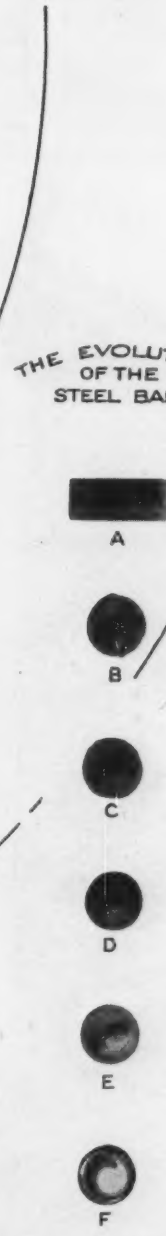

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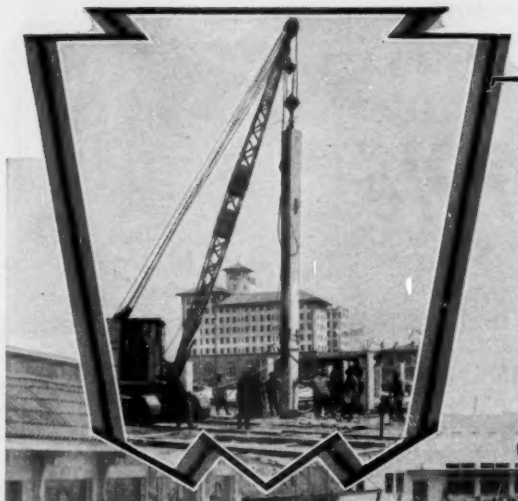

Where Ocean Breezes Blow

AT Ocean City, New Jersey, a new boardwalk — one of the finest of its kind in the world — was recently completed. The entire structure is of concrete with the exception of the decking and rails which saved the name, boardwalk, from becoming concrete walk.

Supporting this sea shore promenade are 780 concrete piles, each 18 inches square, 32 feet in length and sunk 24 feet in the sandy beach. Each pile, which weighed more than six tons, was lifted and located with a Koehring Heavy Duty Crane.

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THE TECH ENGINEERING NEWS

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The First Hundred Years Are the Hardest

WHAT will you be doing ten, fifteen years from now? Fifteen years seems a pretty long time to be worrying about, you say. Yet it's the fellow who looks ahead who usually comes out on top. He builds the foundation now.

The successes of today and tomorrow are built on the foundations of yesterday. In the utility field that statement is particularly true. A power station built today anticipates the needs of the community for many tomorrows. A transportation system is laid to take care not only of the present but of the future riders.

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THE TECH
ENGINEERING NEWS

THE PROFESSIONAL JOURNAL OF THE UNDERGRADUATES OF THE
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

VOLUME X MARCH, 1929 NUMBER 2

The Status of the American Railroads

Their history since the return to private control and their outlook for the future

By EDWARD E. LOOMIS
President, Lehigh Valley Railroad Company

THE role of modern efficient management in promoting industrial stability and in salvaging earnings from erstwhile losses is seldom more strikingly illustrated than in the case of the railways of this country. In fact, their ability to handle an expanding volume of business with increased safety and speed, at lower unit costs, is invariably cited as one of the outstanding features of the economic development of America since the end of the war.

Reviewing the eight years under private ownership and operation, following the end of the Federal-control period, we find that freight traffic has increased about 5 per cent; that freight speed between terminals has increased 19 per cent; that this increased productivity was secured with 16 per cent fewer train-miles and a 14 per cent decrease in the number of railway employes. During this same period the average ton-mile revenue has declined more than 15 per cent. In other words, if the freight rates of 1921 had been in effect during 1927, the public would have paid more than 800 million dollars additional for their transportation service.

Behind this accomplishment there is an investment of more than 6 billion 600 million dollars for improvements since the Transportation Act was passed in 1920. These expenditures for improved railway plant constitute an important contribution by the industry to the commercial activity of the country, as well as a vital contribution to the operating efficiency within the industry itself.

When the railways were returned to private ownership in 1920 following the period of Federal control, earnings were at low point, and the condition of road and equipment was in deplorable shape as the result of the war and conditions which went with it. The Transportation Act provided the terms under which the roads were returned to private ownership. But in addition, the measure in a sense constituted a code of behavior on the part of both the Government's regulatory powers and on the part of the railroads. The Act obligated the carriers to provide the people with adequate transportation, and then stipulated that the railroads should be allowed a fair chance to earn an adequate living under a more stabilized set of conditions than theretofore prevailed.

Mr. Loomis, the author of this article on railroad economics, is President of the Lehigh Valley Railroad, and is also Chairman of the Committee on Public Relations of the Eastern railroads. He enjoys a wide reputation as a writer on such subjects, and we are fortunate in being able to publish his paper at this time.

The article was to have been included in our Railroad issue for February, but due to an unavoidable delay, we were forced to withhold it until this month. We believe that our readers will find it a valuable complement to the railroad material that we have already published.

"In the exercise of its power to prescribe just and reasonable rates," the law states, "the Commission shall . . . establish such rates so that carriers as a whole . . . will, under honest, efficient and economical management and reasonable expenditures for maintenance of way, structures and equipment, earn an aggregate annual net railway operating income equal, as nearly as may be, to a fair return upon the aggregate value of the railway property of such carriers held for and used in the service of transportation. . . ."

The Interstate Commerce Commission has fixed the "fair return" at 5¾ per cent, but in no year since the passage of the Act have the railroads' earnings equalled this return.

In 1923 the railroads "adopted a concerted policy and intensive working program to enable them to meet the growing transportation needs of the country." They authorized an enormous amount of additional capital, largely through borrowed money, for improvements and expansion "on the abiding faith in the fairness of the American people and reliance on the continuance of the policy announced in the Transportation Act of 1920, as a measure of reasonable protection to investment in railroad property." The progressive improvement which the railways are steadily showing in efficient operation is primarily the result of the program of 1923 which has been consistently followed ever since.

It took real courage to come out and secure new capital for equipment and improvements to the railway plant, when for several years the return which the railroads had been earning was far from adequate. It was a brand of courage comparable to that of our pioneer railroad builders. The pioneer roads were indeed pathfinders in that they went into the wilderness and settlement followed. They took chances that the country they penetrated would be settled and that business would follow. That this proved true does not detract from the credit that these early railway investors and planners

deserve for sheer courage and progressiveness.

What has been accomplished with this enormous expenditure of more than 6½ billion dollars averaging some 750 million dollars annually? Broadly speaking, we find that improvements were made in facilities and equipment; that there has been an advance in methods and processes used by management, and that there is a higher morale among the employes.

The American railroads have been among the most aggressive in the world in initiating improvements and intensifying facilities which eliminate waste, increase safety, and add to the amount of transportation produced from each car, each locomotive, and each mile of track. This work has been going along steadily for years to the extent that the railroads' earnings permit, and they must continue it. But no single improvement on a railroad plant can be made in a vacuum. A railroad is by its very nature so integrated, one unit being so dependent upon another, that if a process of improvement is started it must be carried on.

If a more powerful locomotive and heavier cars, for example, are purchased, there must follow heavier rails, improved ballast, better bridges, larger engine houses, longer sidetracks, better stations and yards, more powerful tools in repair shops and better signals for greater safety and speed. Not until these and many other improvements are made can the full economic value of the powerful locomotive be utilized.

These things cannot be created over night. The adoption of such a policy is in itself a most serious undertaking: there must be imagination, sound judgment, careful planning and constant supervision, and credit must be in sight over a long series of years.

There is universal testimony that this policy of improvements has provided the United States with a quality of steam transportation unequalled in the history of this or any other country. In its recent annual report the Department of Commerce finds that:

"The most conspicuous aspect of railway transportation during recent years has been the steady improvement in the quality of the service rendered. Especially important is the fact that cars have been made available promptly when needed. The chronic shortages which were characteristic of the war years and those immediately following have been wholly done away with.

"Equally beneficial to the shippers and receivers of freight and indirectly to the consumers of commodities has been the gain in the rapidity of transportation and delivery. It is estimated that the time required for a given shipment is now at least one-third less than at the close of the war. This improvement in railway service has reduced the costs and risks of industry and of distribution. It has made it possible to do business without carrying excessive stocks of commodities.

"The betterment of railway service has been the result of deliberate effort on the part of the railway companies themselves and of coöperation on the part of shippers and receivers of merchandise."

But the hope that such quality transportation would be rewarded by a rate structure which would yield a fair return on the value of the property devoted to transportation has not yet been realized. The average rate of return on property investment on the Class I carriers in the last eight years has amounted to less than 4½ per cent.

Without entering into any fine-spun technicalities, it is a fact that since the Transportation Act of 1920 was passed, the net railway operating income of the Class I railroads has fallen approximately 3 billion dollars short of a fair return on the money invested

EDWARD E. LOOMIS
President, Lehigh Valley Railroad Company

in railway property. To be sure, all that is water over the dam. The carriers have no enforceable claim on the Government, or on anybody else, for the deficiency, inasmuch as the Act did not "guarantee" the carriers a thing. But the situation does emphasize the fact that the railroads have no margin above the fair return to carry them on from fat to lean years.

This gives point to the question: Must the railroads always be restricted to earnings less than the measure of justice set up by the Transportation Act, no matter how excellent the condition of general business, how efficient the operation of the railways or how good the quality of service? The naming of 5¾ per cent as a fair rate of return is certainly not an excessive rate, if the railroads are to keep pace with a hurrying world.

Business men are unquestionably pleased that railway service is good, but many of them seem to assume that it always will be good — that the railways in some way will get enough earnings to keep the service good, or will keep it good without adequate earnings. There is grave danger that the public will permit itself to be lulled into a condition of comfortable contentment, pleasantly satisfied with existing performance, yet wholly indifferent to the real trend of developments. Admittedly, the railroads are operated to serve the public, but adequate and efficient service cannot be continued indefinitely on the basis of a dwindling return. As viewed by railway management, the persistent deficiency in net railway operating income below the fair return, is not only unjust to railroad investors, but must in the long run be detrimental to the whole business structure of the country.

Yet the railroads continue to be subjected to constant pressure for reductions in rates and for higher wages. In addition, they are suffering from competitive transportation agencies, such as inland waterways, which are actually subsidized by the Government. Since these waterways are not self-supporting, the taxpayer is forced to foot the bill for this barge traffic. At best, the barge lines are ice-bound several months of the year. Moreover, they do not create new traffic as do the railways; they take traffic from existing transportation agencies.

The railways are not opposed to the development of any agency of transportation which is economically sound, and for which there is a public need. In the case of waterways it is important that every project should be analyzed carefully, as to actual necessity, total cost, and probable effects on existing transportation lines. No group of business men would dispose of the problem in any other way, and it will be a great pity if this situation is not handled without politics. The country simply cannot afford to rush into an inland waterway expenditure program that will be of no benefit to the shipper, that may prove to be disastrous for the railroads and an excessive burden to the taxpayer.

Mounting railway taxation is likewise tending to jeopardize the interests of investors in railroad securities and the interests of shippers. It is important to note that the taxes paid by the railroads have increased almost steadily during the last seventeen years, rising from $98,600,000 in 1911 to more than 395 millions in 1927, an increase of approximately 297 million dollars, or 300 per cent.

In 1921 the railroad taxes amounted to $270,000 a day, while now they average over one million dollars a day.

(Continued on page 70)

A President in the Making

The reminiscences of one of the first to discover the remarkable abilities of Herbert Hoover

By WALDEMAR LINDGREN
William Barton Rogers
Professor of Economic Geology
Massachusetts Institute of Technology

For the past several weeks the eyes of the nation have been upon our new President, Herbert Hoover. This article, which serves to give a picture of him at a time when he was in a position similar to that of our own undergraduate days, should therefore be of particular significance. Professor Lindgren, who writes of Hoover as a young man, was associated with the United States Geological Survey from 1894 to 1912, and it was during this period that he had the experience of employing and helping to develop the man who is now hailed as our Chief Executive.

JUST about thirty years ago, in 1894 to be exact, I was sitting in the offices of the United States Geological Survey in San Francisco — the old Appraisers' Building which bravely survived quake and fire — busy planning the summer's work. We were making geological maps of the Sierra Nevada, the Gold Belt of California. In that year I was to attack the High Sierra, particularly that part of it southwest of Lake Tahoe.

A young fellow came in to see me. He wanted a job as assistant, his credentials being the hearty endorsement of Professors Branner and J. P. Smith of Leland Stanford University. He was a senior at Stanford. He was a rather short and thin person, serious of mien, blonde and pale. He did not look just like a stalwart geologist ready to tackle canyons and peaks. A friend of mine, who was sitting close by, appeared a little doubtful, and said: "Well, do you think he will do?" After some consideration I said: "Yes, I think he will. Anyway, a strong recommendation from Branner and Smith goes a long ways with me." So he was engaged at something like $75 per month and board. This young fellow was Herbert Hoover, now President of the United States.

The summer came, time to start for the field. Wagon, pack train, and packer were secured, and the outfit assembled in El Dorado County. Hoover and I went up for a short visit to my mountain ranch in Placer County, but to get up to Placerville was not so easy, for the great railroad strike was in progress, and President Cleveland had just ordered out the army to start the railroads going. Gradually, however, on trains protected by soldiers, we reached the old mining town of Placerville. From then on it was smooth sailing, for with wagon and pack train we were independent, and, in fact, saw no more railroad trains until the fall. For several months our campfire burned in the deep valleys and among the snowpeaks of the High Sierra, and it was a keen pleasure to trace out the geological relations of the rocks, the quartz veins, and the old gold placer channels.

In very short time Hoover proved his worth. He learned how to throw the diamond hitch, to ride horseback, and to follow and locate complex geological contacts. Never have I had a more satisfactory assistant; eager to learn, exact in the recording of observations, and a keen instinct of how to proceed in the simplest way to solve the problems presented to him. Soon he was sent out on independent side trips. Once in a while, however, accidents occurred. For example, leaving your notebook and bag on top of the highest peak in the range may be safe enough, but to retrieve the property was a more or less painful undertaking. There was only one criticism of Hoover that I can remember; he insisted on consuming more condensed milk than the strictly outlined field ration called for. The extra food was perhaps sometimes charged to the mules.

Between Hoover and myself, we mapped one thousand square miles of perhaps as wild and lonely country as the Sierra Nevada provides. When the fall arrived and the work was done and the specimens shipped to Washington for study, we had become great friends, and I now fully appreciated the sterling characteristics of the man.

Hoover proceeded to Stanford, and I went to Washington, and I liked my assistant so much that I engaged him to continue fieldwork with me in the following year, 1895. We started with the same old wagon and packer and mules, only this time the work consisted in a reconnaissance of the boundary region between California and Nevada ranging over the dry country on the east slope of the mountains. I found my friend Hoover greatly improved; his senior year had done wonders for him and he proved of even more assistance than before, being now fully capable of undertaking independent work. We ranged over the mountains all summer and in the fall Hoover did some particularly excellent work in correcting the topography of considerable areas, for in those days the topographic work of the Survey was not what it is now, and the geologist had to follow the surveyor, checking up on his errors. Reluctantly I parted from Hoover; he was not pale and slender any more but had grown to the full size of a geologist.

But, of course, he wanted to go into mining, and the Geological Survey was not to be his principal work. Instead, the world became his field. I gave him a letter of introduction to my friend Louis Janin, the great mining engineer. Janin, then located in San Francisco, took to Hoover at once and sent him first to Carlisle, New Mexico, where gold-bearing veins were being opened; and a little later to Western Australia to take charge of the new properties of Bewick, Moreing of London. From then on his record is fully known.

About two years later, I was giving a course in mining and metallurgy at Stanford. Hoover was gone but in my class was a very bright and attractive girl who for some reason wanted to be well informed on these subjects. The reason, as I now suspect, was Hoover, and the young lady was Miss Lou Henry, now the first lady of the land, and the helpful companion in Herbert Hoover's life work and study, one of the co-translators of that celebrated classic, Agricola's *De Re Metallica*. I remember particularly one of our most enjoyable excursions with the class to the Selby Smelting Works, then managed by my old Freiberg friend, Baron von der Ropp. We went all through the plant and sulphuric acid works and none was more interested in everything than Lou Henry. Afterwards Ropp served us a long to be remembered noon repast at his home.

Several years afterwards it was again my good fortune to be associated with the Hoovers in Australia, particularly in Victoria and New Zealand, where we visited many great mines, at Ballarat, Bendigo and the Waihi, the

(*Continued on page 82*)

The Autogiro

Since its flight from London to Paris, this unconventional airplane has aroused world-wide interest

By ALFRED B. BERGHELL '31

SENOR DON JUAN DE LA CIERVA tells of the birth of the Autogiro in the following words:

"The crash, in 1919, of a big three-engined biplane designed by me for the Spanish Air Force gave birth to the Autogiro machine. This crash was the consequence of involuntary stalling, and impressed me painfully with the fact that aeroplane flight — safety in which, as opposed to all other methods of transport, depends on speed — is entirely contrary to human nature.

Methodical consideration of all possible systems of flying led me to eliminate the aeroplane itself, the helicopter and the many varieties of flapping machines. In my researches for the ideal safe machine certain elaborate theoretical deductions resulted in the discovery of an entirely new system of flying, for which I had to find a name. I chose the word 'Autogiro,' a contraction of 'Auto-giro-pteros' or 'self-rotating-wings,' since the lift in such a machine is obtained by a number of wings or blades freely rotating, without the application of mechanical power, around a common axis which is almost vertical, motion being imparted to them solely by the reaction produced by the wind due to the displacement through the air.

Early in 1920 the experimental period began. Many machines were tested, without any practical result, until two years later I discovered the capital improvement which made the Autogiro possible in practice. The rotating wings, rigidly constructed before, became articulated, flapping freely and maintained in a nearly horizontal position only by centrifugal force. The main aerodynamical and constructional problems were by this method solved automatically. Since January, 1923, Autogiro machines have been flying in the true meaning of the word, and in 1924 a cross country flight of eight miles was achieved in Spain, the first one to be made by a heavier-than-air machine other than the ordinary fixed wing aeroplane."

The appearance of the Autogiro is very similar to that of an ordinary aeroplane with the exception of the wings. In place of the usual fixed wings are a set of rotating vanes, which are carried by an almost vertical shaft or mast over the center of gravity. The mast slopes slightly backwards, the vanes rotating freely around it as an axis. The vanes or blades are each hinged near the base, with the hinge pin perpendicular to the mast. When rotating in flight, the resultant of the centrifugal force and the lifting force produces a position of equilibrium which is conical to a slight extent.

The controls are the same as those of an ordinary aeroplane, the ailerons being carried by a small pair of monoplane wings. These wings give but small lift and are the result of fairing,

THE AUTOGIRO IN FLIGHT
Note the comparatively small wings, and the slowly rotating blades

for better streamlining, the spars originally used to carry the ailerons.

In early experiments different numbers of blades have been used, from two to four in number. The machines now being used have four blades. The shape has also been changed as experiments have shown which design is the more efficient. The pitch angle has a very critical effect on the performance in speed and in climb. Each blade is built up with spruce ribs on a steel tubing spar, and fabric covered. The leading edges are reinforced with three ply, both top and bottom. Adjustable weights are held at the end of each spar, the position of which can be changed in order to obtain dynamic and static balance of the rotor. The inner end of each spar is fitted with an internal flanged socket, which is bolted to a corresponding flange of the outer fork of the secondary hinge of the rotor hub. The bolt holes are slotted to permit changes in the pitch angle of the blades. The rotor hub, which is carried on the steel tube mast, runs on ball bearings. On the hub are formed forks, which carry housings for the roller bearings of the main hinges. A spur wheel for a tachometer drive is also carried on the hub. The forked intermediary member carries the pin on the main hinge in the fork. The secondary hinge is completed by another fork and articulated to the intermediate piece by a hardened steel pin. Thus the main hinge has a roller

(*Continued on page 72*)

AUTOGIRO C. 8. MARK II ON THE GROUND
The lifting surfaces have an almost feather-like appearance

Increasing Recognition for the Engineer

The growing demands and opportunities for engineers to perform public service

By THOMAS C. DESMOND '09
President, Thomas C. Desmond & Co. Inc.

BY the time this article is published, an engineer, Herbert Hoover, will have been inaugurated as President of the United States. No better evidence than this fact can be adduced to help to indicate that men and women everywhere, in our own country and throughout the world, are beginning to give to engineers increased public recognition.

The word "engineers," as used in this article, is to be considered in its broadest sense, including, in general, all constructively minded men who have had scientific training qualifying them to follow technical pursuits, relating to applied science. "Engineers" in this sense are particularly to be distinguished from men such as lawyers or clergymen, who follow professions of importance but professions which obviously call for less scientific training.

It is interesting to remember that the only other President of the United States who could be called an engineer, in addition to Herbert Hoover, was our first President, George Washington. In the years of his early manhood, Washington earned his living as an engineer and land surveyor. In the years of his better known military career in later life, Washington gave ample evidence of his marked engineering ability. The remarkable campaign of Washington in the State of New Jersey is still studied with admiration in all advanced schools of military instruction. This campaign involved many problems of quick transportation, particularly in the Trenton and Princeton Districts. Washington's handling of these transportation problems and other fortification problems throughout the War of the Revolution showed that he was probably as competent and efficient an engineer as it was reasonably possible for a man to be at that early stage of engineering development. When serving as the first President of the United States, Washington gave other proofs of the possession of engineering vision of a high order, for instance, in his recommendations for the adoption of proper plans providing for both the immediate development and the later growth of our national capital, the City of Washington. Only in this generation are we coming to realize, after several past generations of indifference and neglect, that it would be well in the City of Washington to endeavor at once to correct recent errors and to follow more closely, in plans for the future, the original vision of this city as conceived by L'Enfant and Washington.

After Washington there followed a succession of presidents from other vocations than engineering — mostly lawyers. It is not intended to cast any reflection on the legal profession, which is a great and noble calling. It does seem, however, that people are beginning to recognize that it would be well if more engineers should take part in politics and government, coöperating with lawyers and men of other vocations. More engineers in our national and state legislative bodies would be a benefit and so would be more engineer officials in public administrative positions. Time and time again one hears repeated the correct statement that this is preëminently an engineering age. During the recent political, presidential campaign, the facts of Hoover's proved engineering ability and his technical familiarity with many pending national problems, such as those of water power development, Mississippi River Flood Relief, the development of a Great Lakes to the Ocean canal and the development of other inland waterways for the better handling of farm products, were repeatedly stressed by Republican campaign speakers. Since the overwhelming endorsement by the voters of this country of the engineer Hoover, on November sixth last, all engineers in our country, Democrats and Republicans alike, may justly hold up their heads in pride, rejoicing that there has come to a fellow engineer a mark of increased public recognition higher than which it is not possible for any man of any profession in any country to attain in the world today.

THOMAS C. DESMOND '09

The author of this article is President of the T. C. Desmond & Co. Inc., Engineers and Contractors, of New York City, and a former President of the Newburgh Shipyards, Inc. He is Vice-President of the National Republican Club and a former President of the New York Young Republican Club, also former President of the Technology Club of New York and the Technology Clubs Associated.

Until recently, at least, in our own country as well as elsewhere in the world, most of the prizes of public recognition have gone to other men than engineers. Few engineers, for instance, have hitherto been chosen as Governors of our States, or United States Senators, or Ambassadors from the United States to foreign countries, or even, until recently, as leading executives of our largest railroad corporations and other corporations. Most of these positions of very great honor and responsibility have heretofore been held by lawyers or bankers, and many such positions will continue to be held in the future by capable lawyers and bankers, for deservedly good reasons. Morgan F. Larson, an engineer, however, was elected last fall to be Governor of the State of New Jersey. Engineers like Gerard Swope '95, President of the General Electric Company, Alfred P. Sloan, Jr. '95, President of the General Motors Company and Elisha Lee '92, Senior Vice-President of the Pennsylvania Railroad, are now all filling with distinction executive positions of the first class, which legally trained or banker-trained men used to monopolize in former generations. These prominent Massachusetts Institute of Technology graduates, with other engineers from other educational institutions holding similarly high offices today, are helping to prove that engineers must not necessarily spend their lives merely as technical subordinates, but that some engineers, at least, are qualified to hold enormously important and comparatively non-technical positions calling for the highest qualities of responsible judgment.

Let us not forget that it has been only comparatively recently that men

(*Continued on page 76*)

The Cascade Tunnel

A brief account of the record-breaking construction of the longest bore in America

By D. J. KERR
Assistant to the Vice-President,
Great Northern Railway Company

IT is hard to realize how rapidly the Northwest has developed. Forty years ago there was no Great Northern transcontinental line, and it was only in 1889 that John F. Stevens explored Marias Pass in the Rockies and gave to the Great Northern the lowest pass of any of the Central and Northern transcontinental lines of the United States.

With the crossing of the Rockies settled, Mr. J. J. Hill sent Stevens to find the best route across the Cascade Range. Stevens had no instructions except that he should follow Mr. Hill's established practice of opening up new country. The lowest passes across the Cascades were in the vicinity of the Northern Pacific crossing, and Stevens, after exploring the whole country from the Northern Pacific to the International Boundary, selected the pass since known as "Stevens Pass."

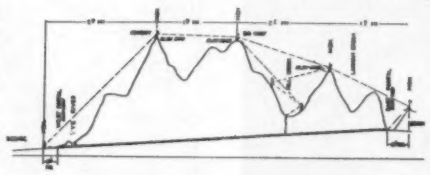

FIG. 2. DETERMINATION OF THE ACCURATE LOCATION
A profile, showing observation points on the axis of the tunnel

At that time the country was heavily timbered, and in locating the new route Stevens felt that the presence of the timber indicated freedom from snowslides. The route he selected appealed particularly to him because it lent itself to immediate construction of a switch back route with 3.5 per cent and 4.0 per cent grades passing over the summit at an elevation of 4,060 feet in the open, and to the construction later of a tunnel which would eliminate the heavy grade switch back section. The permanent part of the line on both east and west slopes of the mountain was built on a 2.2 per cent grade.

The through line to the Coast was put in use early in 1893 and shortly afterwards construction work was started on a 2.6 mile tunnel, which reduced the summit to 3,380 feet, and did away with the switch backs. This tunnel line was opened in 1900 and electrified in 1910.

With such a line across the mountains what was the necessity of a new tunnel?

To understand the situation one must realize the extent of the snowfall in the Cascades. There are records of two winters each having an aggregate fall of 56 feet of snow at the east portal of the old tunnel. This snowfall diminishes at the rate of over a foot for every 100 feet decrease in elevation, *i.e.*, a point on the mountainside with an elevation of 1,500 feet would have a snowfall during the winter 15 or 20 feet less than a point at an elevation of 3,000 feet.

Further, the destruction of timber, principally by fire, following the construction of the railroad, permitted small slides to begin which in turn cleared paths for more extensive slides. As time went on, more and more snowsheds were built until there were nearly seven miles of these sheds.

The snowslide areas were confined to two sections of the line: (1) on the east slope in the Tumwater Canyon of the Wenatchee River between Leavenworth and Winton, Washington; (2) on the west slope from the west portal of the old tunnel at Tye to Scenic, where the old line is folded back on the steep mountainside. The map, Fig. 1, shows these limits.

A program of improvement of the line which would eliminate the hazard and expense of the snowsheds was therefore undertaken; a program which at the same time would improve alignment and grade.

This plan consisted of three things:

(1) The construction of a new line known as the "Chumstick Line," about 19½ miles long, which permitted the abandonment of the old line between Leavenworth and Winton and gave a line on the east slope entirely free from snowslide danger.

(2) The construction of a long tunnel which would permit the abandonment of all of the line on the west slope subject to snowslides.

(3) The electrification of the 75 miles of line from Wenatchee (on the east slope) to Skykomish (at the foot of the west slope).

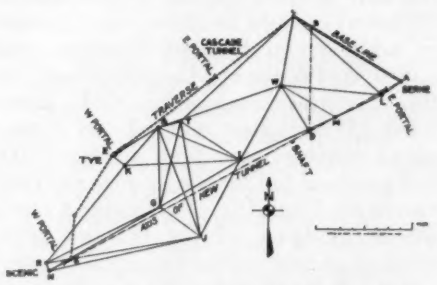

FIG. 3. SURVEY OF THE TUNNEL
The triangulation system of verification is clearly shown

The construction of the Chumstick Line and the electrification are in themselves major construction projects, but their importance has been dwarfed by the outstanding nature of the tunnel work with which this article deals.

Following serious snowslide difficulties in 1910 the possibility of a long tunnel line was discussed and from time to time studies were made and different routes were considered. A very complete report was made in 1917 by Mr. E. J. Beard, which gathered together all of the data then available and outlined the relative advantages and disadvantages of the various lines with projected long tunnels from seventeen to eight miles in length. The longer tunnel lines gave maximum grades across the range of 1.4 per cent, while the eight-mile tunnel scheme left short sections of 2.2 per cent grade.

It was apparent from Mr. Beard's report that there was little likelihood

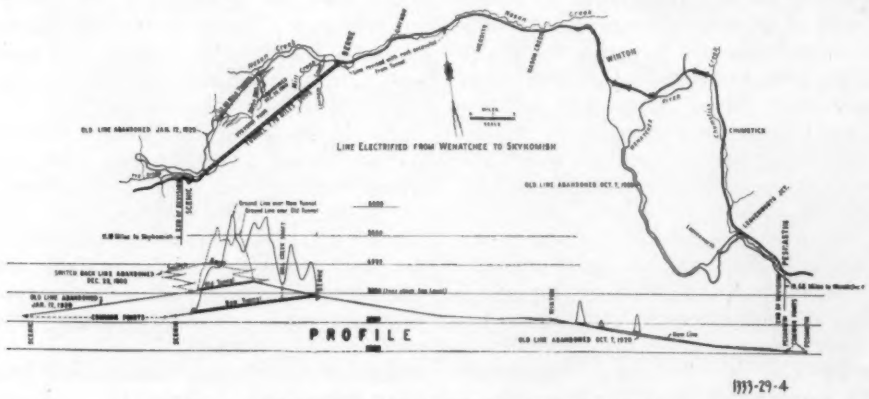

FIG. 1. MAP OF THE IMPROVED SECTION
Excessive snow in this area necessitated several improvements, among them the Cascade Tunnel

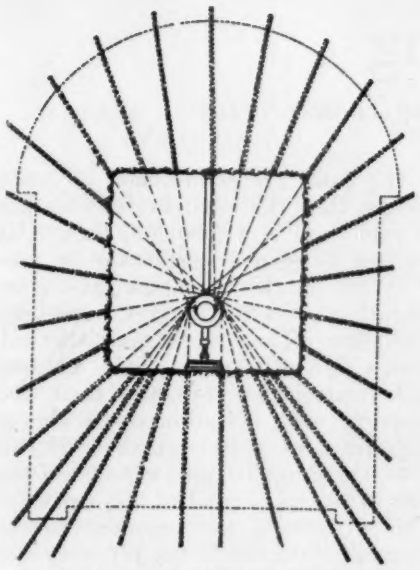

FIG. 4. PLAN SHOWING RADIAL DRILLING FOR ENLARGEMENT
Depth of holes depends on thickness of concrete, which depends on character of rock

of any scheme being justified financially except one which involved the shortest of the projected tunnels. Traffic is not heavy and the operating economies from using a lower summit, lower grades, etc., were not great. The main economy was that of the elimination of snowshed maintenance expense. That expense was practically ended by any one of the lines considered so that the conclusion was inevitably reached that if any line were built it should be a line directly from Berne on the east slope to Scenic on the west, involving a tunnel somewhat less than eight miles in length. Mr. John F. Stevens made a study of the subject in 1925 and endorsed this conclusion.

It was not until late in November, 1925 that the Board of Directors authorized the work, and the engineers under Col. F. Mears, Assistant Chief Engineer, were faced with the difficult task of determining a final and accurate location under very adverse weather conditions. Figs. 2 and 3 will illustrate the work done.

In the first instance, the line across the mountains was run with light mountain transits in order that construction work at the portals could be started without delay. Later precise transits were used and the line was finally established by means of a theodolite having a 22-inch telescope and reading to two seconds of arc. This theodolite when used was mounted on threaded sections of 6-inch pipe, the lower ends of which were embedded in concrete.

The distance between portals was determined from a traverse illustrated by Fig. 3, the longest leg of this traverse being through the old 2.6 mile tunnel.

As a final verification a triangulation system was laid out which can also be readily followed from Fig. 3.

The age of the snowsheds and the great saving from eliminating snowshed maintenance, even for one year, made it particularly desirable that the work be done in three years — so that the new route could be used prior to the snowslide period of the 1928–29 winter.

Most of the long tunnels of the world have been laid out with summits at or near the middle so that work from the portals could be prosecuted successfully, irrespective of water conditions, uphill from each end. In the case of the Cascade Tunnel the situation did not permit doing this and the entire tunnel as indicated by profile, Fig. 2, is on an up-grade of 1.565 per cent from west to east — the summit being close to the east portal.

It was recognized that work from the east portal might be stopped if much water were encountered and it was, therefore, decided to attack the work from three main camps — the first at the east end at Berne, the second at Mill Creek where the line crossed a valley at a point about 2½ miles from the east portal and where the tunnel grade was 620 feet below the surface, and the third at the west end at Scenic.

Unless unusually bad conditions developed it was clear that the section from the east portal to the shaft could be completed well within the time set and that the real problem lay in the section between the shaft and west portal at Scenic.

In order to provide sufficient working faces to meet the time schedule on the 5½ miles between Scenic and the shaft, it was decided to follow the pioneer tunnel scheme (as was done in the case of the Simplon tunnel) and also to put down an incline shaft about half a mile east of the west portal. The necessity of this incline shaft arose from the fact that the ground at the west end of the tunnel consisted largely of mountain debris, disintegrated granite, etc., and much time was required to work through this soft material. By putting down the incline shaft access was had directly to the more solid rock of the mountain, and the loss of time was avoided. From the incline shaft to the east portal the material encountered was granite or altered granite with many faults, water-bearing seams, and in many cases graphite seams.

The carrying out of the work was turned over to A. Guthrie & Co., contractors of St. Paul, Minnesota, on November 26, 1925. Camp construction was started December 1, and excavation on December 14, 1925. The shaft at Mill Creek camp was begun January 30, 1926 and completed August 5, 1926. This shaft is a four-compartment one, 8 by 24 feet, one opening being a pipe and safety way, two being used for balanced bucket hoists and one for the man and material hoist.

The tunnel "line" was carried down this shaft by means of two piano wires set 19 feet apart, each carrying a 60-pound plumb bob. It was from this short base line that the centers were set for a distance of 3,300 feet easterly to the junction with the line from Berne — the error at that point (9,500 feet from the portal) being:

Alignment	0.23 ft.
Elevation	0.20 ft.
Distance	0.90 ft.

Between Berne and the Mill Creek shaft practically no water was encountered and, ground conditions being fairly good, that work proceeded rapidly both down hill from Berne and up hill from the shaft — the center headings meeting March 4, 1927. Enlargement of the center heading (Fig. 4) by radial drilling or by such other method as ground conditions necessitated, was started immediately thereafter from the Berne end only

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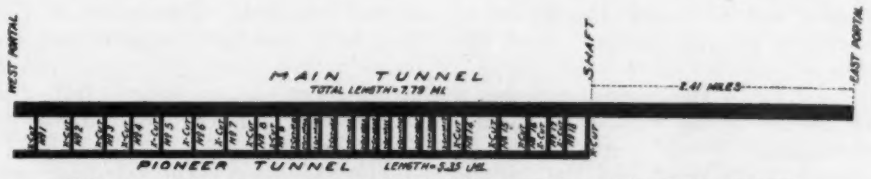

FIG. 5. PLAN OF ATTACK BETWEEN SCENIC AND THE SHAFT
The level of pioneer tunnel was dropped to drain the heavy water flow encountered

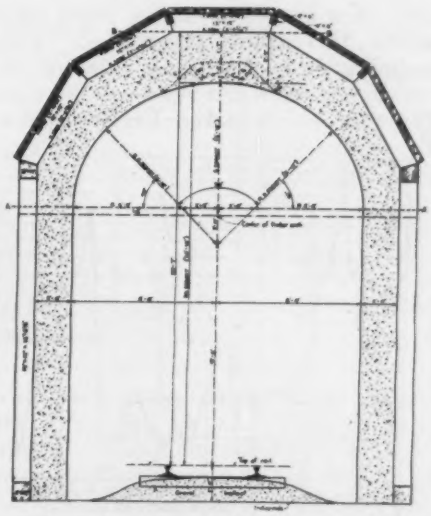

FIG. 6. FINISHED TUNNEL SECTION
The character of the rock required lining throughout

Valuation Engineering

The problems involved in the appraisal of public utilities

By BANCROFT HILL '11
Consulting Engineer

SINCE the writer's graduation, eighteen years ago, there has developed a subject, then little known, which now claims a great deal of engineering thought and ability, whose technical terms are in constant daily use, although in many cases only partially understood by their users. This subject is the valuing of public utilities. The purpose of this article is to present a brief sketch of this division of engineering, some of its problems and their treatment. The information given can doubtless be found piecemeal in various weighty textbooks on law, appraisals, public utilities, indices, and on depreciation. These present not only the bare outline given here, but a great many other matters besides. This article is designed not to weigh the value of one theory against another, as to the rights of property or of "the people," but to give to the young engineer a brief picture of the work of the valuation engineer.

About thirty years ago, the various states began to pass laws lowering the rates which utilities, such as water companies, gas companies, and railroads might charge for their services. These public utilities took refuge under the Constitution of the United States on the theory that their property was being used by the public without proper compensation and thereby taken from them without due process of law. This brought up immediately the question as to what was the value of the property involved, as rates which did not give a proper return on that value would be, in effect, confiscation. For over twenty-five years preceding this time, prices had been declining from the peak existing at the time of the Civil War, as shown in Chart 1, which is the United States Department of Labor's wholesale price trend for the United States. The utilities claimed that they were entitled to a fair return on the money invested in the property and their opponents claimed that the cost to reproduce the property was the proper base on which to calculate the return. This was the natural reaction because at that time reproduction, and especially reproduction less depreciation, was less than original cost. By reproduction is meant the cost to reproduce the whole property under the conditions and prices existing at the time in question. By original cost is meant what was actually paid for the property when it was installed. The courts at that time held that both original cost and reproduction must be considered in arriving at a valuation but that neither cost nor reproduction was the controlling factor.

This valuation is the rate base upon which the return to the owner of the property is computed. The commission or court must then determine the percentage on this valuation which the property will be allowed to earn. This percentage is called the rate of return, and generally varies, at the present time, from 7 per cent to 8 per cent. It may be more, but is rarely less, for the return on the property must be enough to attract investors to assume the risk which is attendant upon the business. If the return is too low, the utility will not be able to obtain from the investing public sufficient capital to properly supply its extensions. A simple example will best show how the rate base and rate of return are used.

If, after considering all of the facts in the case, the commission or court decides that the company's valuation or rate base is $1,000,000, then it is entitled to earn a percentage or rate of return on this rate base, above its operating expenses, taxes, and depreciation. That is, if operating expenses are $100,000, taxes $25,000 and depreciation $40,000, then the property will be allowed to charge such rates as would return to it this $165,000 annually, plus $75,000, if the rate of return is fixed at 7½ per cent. This $75,000 is the payment to the owners for the use of the property and it is entirely independent of whether the property is over-capitalized or under-capitalized. If the owners have issued securities for $2,000,000, then they are allowed to earn on only one-half of that amount; if they have been fortunate enough to be able to build their plant on $500,000 capital, they have a surplus of plant value over capital. It does not make any difference whether they built the plant by subscriptions to common stock, which means they have no funded debt, or whether they built entirely on borrowed money; the valuation is still the same and the return is still $75,000.

The courts in the early cases decided that there were at least four things which must be considered in a valuation or rate case, and that there might be others. These four were original cost, reproduction cost, market value of securities, and earnings under the rates proposed in the statute. Of these four, only two have survived. It was found that the market value of securities was in most cases absolutely dependent on the earnings of the plant, which were in turn dependent on its value and the rates charged, so that in this case, in two

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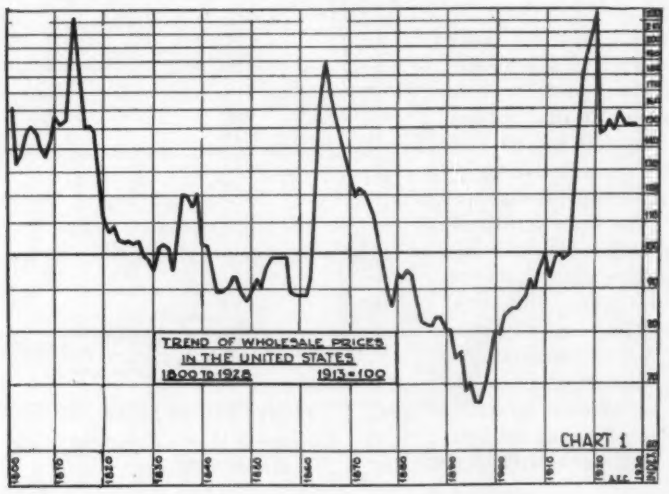
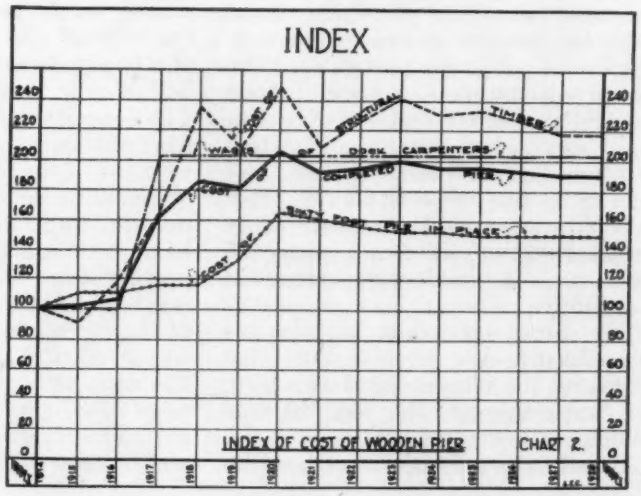




Editorials

FINE WORK FROM FINE TOOLS

One of the many striking characteristics of American life is the figure of the self-made man. And yet, how many of our captains of industry, how many of our leaders in the sciences and arts, are really, in the last sense of the word, self-made men? Unquestionably, there are some who have literally "lifted themselves by their boot-straps," who can claim entire and complete responsibility for their success. However, by far the majority of those whom we consider outstanding are graduates of the finest educational institutions of the country. They have had valuable friends who have contributed much to the development of their character and pointed the way to success.

Here at Technology, we are offered exceptional advantages in beginning an engineering career. A brilliant instructing staff such as is ours implies a training in the fundamentals of the engineering professions which is second to none. The complete and constantly expanding equipment of the Institute laboratories affords practical experience far beyond the possibilities of many technical schools either in America, or abroad.

To us, as undergraduates, falls the responsibility of realizing the opportunities which are being offered. No more than it expects inaccurate work from a machinist equipped with precision instruments, does the world expect mediocre performance when we play our part. Having partaken of the best, we must give the best in order that we may prove ourselves worthy of the confidence of those who have dealt with us so generously.

PROFESSOR JAMES R. JACK

For the subject of the first of the series of faculty sketches which THE TECH ENGINEERING NEWS is planning to present, Professor Jack, head of the Department of Naval Architecture and Marine Engineering, has been chosen. As one might expect, his life has been one that is closely related to the shipping industry. Born in Glasgow, Scotland, when he reached the age of six his parents moved to Helensburgh, on the bank of the River Clyde. His boyhood was spent in an atmosphere of the sea, as he daily watched new vessels sliding down the ways and others steaming up the river to the shipyards for repairs.

When sixteen, on having completed the equivalent of our high school education, he started work in the shipyard of William Denny and Brothers as an apprentice. At that time, the subject of Naval Architecture was not taught at any of the leading schools, and the only way in which one might acquire a knowledge of it was in the industry itself. For two years he served his apprenticeship, continuing his studies in an evening school conducted for training men in the scientific side of shipbuilding. At the end of this time, successful in a series of competitive examinations, he advanced into the drafting room and began actual work on design.

In addition to his regular work, he enrolled as a special student in the courses in Naval Architecture recently established at the University of Glasgow. While there, he won first honors in each of the four courses which he took. In 1894, the chair being vacant, he became Lecturer in Naval Architecture at the Royal Technical College in Glasgow, which, founded in 1796, is the oldest technical school in the world.

From 1901 until 1914 he was Chief of Technical Staff of the Denny shipyard, and was responsible for the design of over three hundred fifty vessels, from Atlantic liners to high-speed gasoline motorboats. Under his direction, the first turbine propulsion merchant ship, the *King Edward*, and the first combination of a reciprocating steam engine and an exhaust turbine, the *Otaki*, were developed.

At the outbreak of the World War in 1914, he took charge of the entire yard and although the war-time specialities of this shipyard were destroyers and submarines, many other craft adapted to war purposes were built as well. In addition to marine construction, the plant carried on airplane assembly, airplane propeller manufacture, and numerous other varied types of work. At the end of hostilities he was among the first to be decorated by King George V with the Order of the British Empire, then newly created as a reward for valuable war service.

In 1919, President Maclaurin invited him to take charge of the Department of Naval Architecture and Marine Engineering upon the retirement of Professor Peabody in the following year. He accepted, and instead of directing the labor of 2,500 workmen in a bustling shipyard, he now draws upon his years of experience both in the theoretical and practical fields of the subject in the instruction and guidance of the eighty or ninety students enrolled in his course.

In the professional societies, Professor Jack is a member of the Institute of Naval Architects (London), the Institute of Engineers and Shipbuilders (Scotland), and in this country, the Society of Naval Architects and Marine Engineers. He is a Fellow of the American Academy of Arts and Sciences and President of the New England Botanical Club. Among social organizations, he is a member of Theta Chi and Theta Tau fraternities, the Boston Propeller Club and President of the Boston Alumni Chapter of Theta Chi.

THE PHYSICIST

The mention of a physicist brings to the minds of the uninitiated a picture of a somewhat grubby individual who spends most of his time in a laboratory, coming to the surface occasionally for food and sleep. That any young man should be willing to devote his life to physics is beyond their comprehension; they regard him as a specimen to be placed under a glass case. Perhaps the reason for this attitude is that the physicists of the past studied physics as a hobby, their real business being something else; and people who follow a hobby seriously rarely get any sympathy from anyone not similarly afflicted.

The popular notion of the physicist has been changing since the beginning of the century. It has not yet reached the point where he gets the universal reverence that the engineer is accustomed to receive, but the large corporations have been discovering that he is a very useful person. The demands on our schools for trained research men have reached the point where they cannot begin to fill them. Under the pressure of these requests the curricula of our schools are being gradually revised to meet the need of industrial corporations for men trained in the practical, industrial side of physics. There is, too, a tendency among corporations to leave in the hands of the person who has originated something new the engineering and the commercial developments associated with it, instead of setting him to work at something else. His success will depend on the number of different abilities he commands. The opportunity for developing all the inherent qualities a man possesses could hardly be equalled elsewhere.

ELECTIONS

The Managing Board of Volume X regrets to announce the resignation of Irvin R. Mitchell '31 as Managing Editor. It takes pleasure in announcing the following elections: Christian E. Grosser '31, Managing Editor; John H. Dodge, Jr. '31, Associate Editor; Charles W. Rankin '31, Assistant Managing Editor.

THE COVER

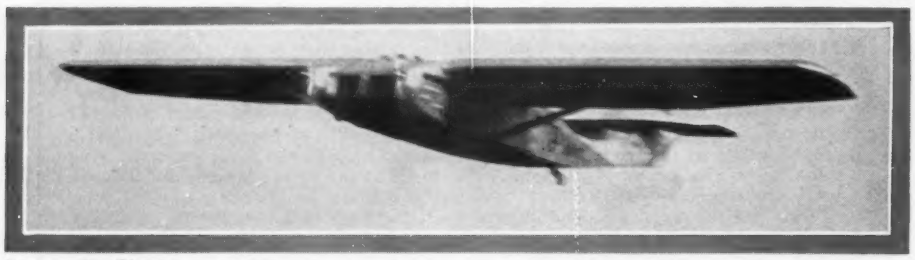
"The Hudson River Bridge Under Construction" is the title of this month's cover illustration by O. Kuhler, reproduced through the courtesy of the Schwartz Galleries. It shows the New York tower of the 125th Street bridge, which, on its completion, will be the largest suspension span in the world.

The Engineering Field

Abstracts from the leading professional and trade journals

The Burnelli Monoplane, "Airliner," recently constructed, is one of the latest evidences of the rapid strides being made in the development of modern aircraft.

The fuselage of the plane, which is especially designed to reduce landing speed, is 36 feet long and 12 feet wide and has a lift of four pounds per square foot. The wings, which are of the transverse stringer type, have



Courtesy *Aero Digest*

NEW MONOPLANE WITH WHEELS RETRACTED

a square foot lift of about 14½ pounds. In order to minimize the wind resistance, the ship is fitted with a retractable landing gear that can be operated by a lever from the cockpit. The wheels may be retracted in seventeen seconds and extended again for landing in eight seconds. When the wheels are retracted, a red electric light serves as a warning to the pilot.

Power is obtained from two motors of 700 h.p. each, which are mounted on a triangular frame so that they may be swung out from their original position, making repairs much less difficult. Two 280-gallon tanks in the wings and one 440-gallon tank in the cabin furnish the fuel for the mammoth engines. The "Airliner" has a cruising speed of 115 miles per hour and a maximum speed of 145 miles per hour.

In designing the interior of the cabin, every effort was made to furnish it in the most luxurious manner possible. The chairs are heavily upholstered and may be made to assume any position from upright to recumbent. There are electric lights throughout, several base plugs even being provided for reading lights. As a final refinement, the cabin is made soundproof with Balsam Wool, and the engines are muffled so that the plane rides as quietly as an automobile.

A New Airport Floodlight of three million candlepower has been perfected for use in large airports. In the new light, the conventional circular lenses and mirror are dispensed with and instead, fourteen high power incandescent lamps are arranged in a row in front of six mirrors of special optical glass which are parabolic in the vertical direction and plane in the horizontal. The mirrors are each 36 inches high and 15 inches wide.

Due to the parabolic construction of the reflecting surfaces, none of the light rises into the air high enough to interfere with the vision of a pilot landing directly into the beam of the light, but the light is spread over the field where it is most needed.

Fuel Oil has been successfully used as a fuel in bus operation in a recently developed system requiring no complicated mechanism, and in which starting may be accomplished without the use of gasoline.

The key to the development is the Godward gas generator, which is an aluminum pot having a series of stationary thin curved plates which radiate from a central core. The bottom edges of these plates rest on the aluminum pot which is heated by the exhaust of the engine, and the fuel, which is usually 38–42 Baume Oil, is drawn in by a standard carburetor, over the surfaces of the warm plates, which converts it into dry gas. The gas then passes through the intake manifold into the cylinders. In starting, the fuel is heated by means of an electric heating unit, which receives energy from a storage battery using 80 amperes at 12 volts for about one minute. Also a special intake manifold is used which has no sharp bends, high spots, or pockets, and has larger cross sectional areas, all of which allows an increase in the quantity of mixture entering the cylinders, thereby increasing the volumetric efficiency of the engine.

No special equipment is needed, and gasoline may be used instead of fuel oil whenever needed without making any adjustments. With a reduction of nine per cent in fuel consumption and five per cent in carbon monoxide content of the exhaust, fuel cost has been diminished 29 per cent.

A Battleship of only 10,000 tons displacement, one of four provided for in the present armament program, is now under construction in Germany.

The ship, though no larger than a cruiser, is almost as heavily armored as a dreadnought. It has six 11-inch high angle guns mounted in triple-armored turrets and firing three shots per minute at a maximum range of 30,000 yards, eight 6-inch rifles, anti-aircraft guns, and six deck torpedo tubes. Its cruising range is 10,000 miles at a speed of 20 knots, and it has an announced maximum speed of 26 knots. In order to incorporate these many advantages in a ship of only cruiser size it was necessary to use a special light steel developed by the Krupp engineers, electrically welded seams and joints throughout, and to use extraordinarily light Diesel engines weighing only 17 pounds per horsepower. These engines, developing 50,000 horsepower, add enormously to the cost of the ship, the total of which is reported to be about $20,000,000.

The World's Largest Steam Locomotive, measuring three times the length of a freight car, has been built for the freight service of the Northern Pacific Railroad.

This iron giant, riding on 34 wheels, is of the four-cylinder simple Mallet type, has a length of 125 feet, a width of nine and a half feet, and a height of sixteen feet, four inches. Complete with coal and water, it weighs 1,116,000 pounds and has a normal tractive power of 140,000 pounds. The enormous firebox, which is twenty-eight and a half feet long and nine and a half feet wide, has a grate area of 182 square feet and is equipped with five thermic siphons, three of which are in the firebox and the other two in the combustion chamber. A special mechanical stoker can, at a maximum, distribute 22½ tons of coal an hour, while the tender has a capacity for 27 tons of coal and 22,000 gallons of water, the latter being supplied to the boiler by two centrifugal pumps.

Because of its enormous power this locomotive is to be used along a 216-mile stretch in Montana and North Dakota where it is impractical to set up helper or pusher districts for the grades there.

A Rubber Lumber, known as "Aeroboard," has been put on the market for use in light aircraft construction.

The material is essentially two sheets of thin hard rubber with a filling of rather hard sponge rubber between them, and a fabric woven in to give strength to the material. It is also possible to make one surface of the material either of fabric or metal. When metal is used, it is welded on the rubber by the "Vulcalock" process.

Besides being used for aircraft construction, the rubber lumber is also excellent for use in speedboat construction because it has light weight, great strength, waterproof qualities, and ease of handling.

Burning Away Stumps of trees rather than digging or blasting them out has come much into favor among farmers since the announcement of a method whereby cost may be reduced to as little as one tenth of that of blasting.

To a conventional vacuum cleaner is attached a special fitting which allows six or eight ⅝″ or 1″ hoses to be fitted to the end from which the dustbag is removed. These hoses are then attached to pipes which in turn are inserted into holes drilled a few inches into the different parts of the stump or stumps. At the bottom of each of these holes is placed a burning piece of charcoal which, fanned by the blast of air from the pipe, soon ignites the stump. As the wood burns away the pipe is pushed farther and farther in until finally the roots themselves are reached. Large stumps have been found to take from eight to twenty hours, depending upon how wet and how rotten they are.

The advantages of this method are that roots may be burned out far down into the ground without digging or blasting and consequently with little filling to be done afterward, and the entire job may be done by an unskilled person.

A New Graving Dock, which will be the largest in New York harbor, is now being constructed in Erie Basin, Brooklyn, for the Todd Shipyards Corporation and is to be completed this fall. This dock will be 715 feet long, 113 feet wide at the top, 93 feet wide at the bottom, and will have a floating steel gate weighing 500 tons.

The inshore and outshore sections are being constructed separately. The construction of the inshore 500-foot section of the dock is unique, for, instead of requiring an immense amount of concrete to make it watertight, sheet piling is used to cut off the water flow. The center of the dock is open, allowing ground water to drain up through the floor and be discharged by drainage pumps. The outshore section is being constructed without removing any water, by excavating the site with dredges, laying steel trusses across the dock on timber piles, and finally placing concrete between the trusses. When this is finished, the area will be pumped out and the walls and floors connected with the inner dock, which will be completed about the same time.

The pumping plant will have two large 48-inch spiral screw pumps driven by two 700 horsepower motors, making it possible to unwater the dock in less than two hours.

Courtesy *Marine Engineering*

INSHORE SECTION OF NEW GRAVING DOCK

The Largest Turbine now in operation was recently installed in the Hell Gate plant of the United Electric Light and Power Company. The unit, which is a cross compound machine consisting of a high pressure unit running at 1,800 r.p.m. and a low pressure unit running at 1,200 r.p.m., has a maximum output of 160,000 kw. The most economical output is 90,000 kw.

When running at maximum load and non-bleeding, 1,710,000 pounds of steam per hour or 3,600 gallons of water per minute are admitted to the turbine.

Bobbin Support Breakage is eliminated in a new loom, for no part of the support enters the shuttle to drop the bobbin so that the shuttle may pull forward the thread in the process of weaving.

A swing arm is hung from the center of the support to feed the bobbins down through the hopper stand. This arm has a spring on it to bring it back to position for taking another bobbin after it unloads a bobbin. This gives it a backward motion instead of the downward motion which is characteristic of the common bobbin support arm.

With this latter type of arm, if it does not come up immediately due to a too large yarn package, yarn spun over the rings, or some loose parts in the hopper stand, the shuttle breaks off the arm, which is a familiar nuisance and expense.

The change has reduced the number of incomplete transfers of the bobbin from support to shuttle to a minimum and results in a loom more effectively automatic, with less stops, and fewer and easier repairs.

A New Accelerating Clutch is now being manufactured for use between an electric motor and the driven machine that greatly reduces starting torque and permits the machine to start with a uniform acceleration.

The clutch, which is similar in principle to the ordinary disk clutch, is mounted as a coupling and operates entirely by centrifugal force. Friction is produced between a metal disk keyed to the shaft of the motor and frictional surfaces that revolve with the machine being driven. In operation, adjustment is made so that there is just enough friction to cause the machine to rotate after the motor has reached its maximum speed. As the output shaft gradually rotates faster, weights that revolve with it are thrown outward by centrifugal force, and push rods connected to them cause more friction in the clutch and a consequent increase in speed. At full speed the friction is so great that the clutch becomes a solid coupling.

A clutch of this type has the advantage of permitting a smaller motor and a less complicated electric control. It also protects the motor from overload by allowing it to run almost free when the speed is retarded greatly.

Hydrogen Gas is now being used to cool electric machinery in a new system. By including the gas within a totally enclosed rotating machine, the effect of corona on the insulation is eliminated and fifty per cent more power may be obtained without increasing the operating power above the safety point.

Departmental Notes

DEPARTMENT OF AERONAUTICAL ENGINEERING

THE new Daniel Guggenheim Aeronautical Laboratory, which was dedicated last June, has proved indispensable in taking care of the large increase in the number of students in Course XVI. Various minor items of work which were not finished when the building was occupied have now been completed, and the new facilities are in full use.

A laboratory for the new work in Meteorology has been equipped under the direction of Prof. C. G. Rossby, whose appointment as Associate Professor of Meteorology last September was made possible by a grant from the Daniel Guggenheim Fund for the Promotion of Aeronautics. A forty-foot steel tower carrying a wind direction indicator and an anemometer has been erected on the roof, and other meteorological instruments have been installed in a small house at the base of the tower. An intensive program of courses in Meteorology is being offered, and a group of six officers has been assigned to the Institute by the Navy Department to take these courses. These officers were prepared for this work at the Post Graduate School, at Annapolis. The courses are open also to other students in the Institute.

A new five-foot wind tunnel, of the same design as the present seven and one-half foot tunnel, is rapidly nearing completion in the smaller of the two wind tunnel rooms in the basement of the building. It will be used both for research and for instruction. With the completion of this tunnel the Institute will have three wind tunnels in operation.

Preparations are being made to move the equipment of the Aero Engine Laboratory to the new building which has been erected behind the Daniel Guggenheim Aeronautical Laboratory. This new power plant laboratory will afford materially increased facilities for research work in aircraft power plants, and will give the Institute exceptional facilities for these studies.

Prof. W. G. Brown has been engaged during the past term in procuring equipment for the new aircraft instrument laboratory. This equipment is intended particularly for the testing and calibration of the instruments which are used in airplane performance testing, and will make it possible for members of the staff to conduct performance tests on commercial airplanes and to certify to the results of the tests. Under the direction of Professor Brown, Mr. Kelsey has been designing a new machine for testing wing ribs which promises to do this work much more quickly and conveniently than has been possible with machines of the types now in use. Construction of the new testing machine has been started.

The policy of limitation of students in Course XVI, which was announced last spring, has now been put into effect with the class of 1931. Of sixty freshmen who applied for the course, thirty were accepted. It appears that a very fine group of men has been obtained, and the faculty is watching their work with a great deal of interest. The number of candidates for Course XVI in this year's freshman class is considerably larger than in that of last year and the selection will therefore be still more rigorous, as only thirty men are to be taken. The applications for transfer to Course XVI from other colleges and from other courses in the Institute are being studied with unusual care, and many of the transfer students have been required to register as unclassified. They will be admitted to the course when they have shown that they can do as good work as that being done by the average of the men already in the course.

PROF. DAVIS R. DEWEY

Head of the Department of Economics and Statistics, and in charge of the course in Engineering Administration.

The number of institutions giving courses of college grade in Aeronautical Engineering is increasing very rapidly, and it is felt that the policy of the Institute in sacrificing quantity to quality is more than justified.

CHARLES H. CHATFIELD.

DEPARTMENT OF ECONOMICS AND STATISTICS

During the past year the Department of Economics has taken steps to widen its activity and opportunities for students in the Course in Engineering Administration by securing the appointment of Fairfield E. Raymond as Assistant Professor of Industrial Research. During the last twenty years industrial engineers have developed management technique in a wide number of scattered establishments. Notable work in this field has been fostered by the Taylor Society. A large amount of experience has been gained, but as yet it lacks coördination, in order to lay down, if possible, universal principles which are applicable to management in general. This growing appreciation of the need of improved technique in management is further seen in the recent establishment of a Management Division of the Society of Mechanical Engineers; by the organization of an Institute of Management by the American Management Association, and by the proposed efforts of the Department of Commerce to make investigations of certain problems relating to management. It will be the effort of Professor Raymond to bring together this scattered experience and make the results of various industrial research organizations more available for departmental service and study.

Mr. Raymond will also devote attention to certain concrete problems, as for example: Economic production quantities; obsolescence and depreciation; economic factors of equipment; determination of order point and minimum stock; economic factor of spoilage and inspection; economic purchase quantities.

During the last two months he has given special attention to the practical application of the theory of economic production quantities to specific industries, in order to demonstrate that the general formula can be simplified to suit each case. A rapid method for selecting suitable expressions has been developed, including certain limits for governing their use. It was found that considerable variation from the economic quantities would be permissible and that greater latitude in the control of production schedules could thus be obtained. The value of such research is emphasized by the fact that several industrial concerns have shown interest in having this study extended to include their specific problems.

One of the most important problems

(*Continued on page 70*)

"Thumbs up"
the spirit of industry . . .

FOR every race or game or debate that one team wins, another must lose . . . It's forever "thumbs up" or "thumbs down", according to which side you are on. But in industry there's one side only.

Enlightened industry backs every man on her teams. For it is to industry's advantage to see that every man makes good.

Here you have an inspiring picture. Co-operation. The "vet" encouraging the novice. All industry rooting for achievement.

It is not surprising then that so many men have found the interests of after-college years fully as broad and as absorbing as those of undergraduate days.

Western Electric

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Recent Books

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Speech and Hearing. By HARVEY FLETCHER, PH.D., *Acoustical Research Director, Bell Telephone Laboratories, Inc., D. Van Nostrand Co. Inc., New York. XV+331 pages, illustrated. Price $5.50.*

Recent developments in telephone engineering have made necessary a vast amount of research on how man speaks and how man hears. Much of this research has been conducted at the Bell Telephone Laboratories, New York City, and results have been published from time to time in our leading scientific journals. This work by Dr. Fletcher has for its main purpose a collection of these researches in book form, and it should be gratefully received by those interested in this phase of acoustics.

The book is broadly divided into four parts. Part one deals with the mechanism of speech, artificial production of speech sounds, speech power, statistics of the frequency of occurrence of different speech sounds, and the development of methods for the recording of speech waves, including a discussion of such apparatus as the phonautograph, the phonograph, and the high quality oscillograph. The author favors the universal adoption of the "Decibel" as a unit to represent levels of intensity.

Part two deals with the characteristics of musical sound waves, acoustic spectra of musical instruments, ranges of frequency and intensity for music, and some physical properties of noise.

Part three deals with the mechanism of the ear, the functions of the various parts of the ear, mechanism of nerve conduction, frequency and intensity sensibilities, masking and methods for testing acuity of hearing.

Part four is devoted to the perception of speech and music, methods of measuring the recognition of speech sounds and effects of change in intensity, frequency distortion, noise and deafness on the recognition of speech sounds.

This work is not complete because so many of the problems involved are in their infancy and adequate solutions are yet to be found. Dr. Fletcher is to be congratulated, however, in giving us such an up-to-date as well as extremely fascinating treatise.

W. R. BARSS.

Fundamentals of Quantitative Analysis. By WALTER C. BLASDALE. *403 pages, illustrated. D. Van Nostrand Co., Inc., New York. Price $3.75.*

In this third edition of the text the author has revised and amplified the material included in the previous editions. The book is intended as a college text for a year's work by students having at least one year of general inorganic chemistry. The theoretical chemistry underlying the methods taken up is gone into in detail and the homogeneous and heterogeneous equilibria upon which such processes depend are discussed and emphasized. Problems of a general nature, as well as those involving stoichiometry, are included. The author assumes that emphasis on the later type of problem is not necessary.

The book is well arranged, discussing the major methods of quantitative analysis in some detail and includes a sufficient number of well chosen determinations to illustrate them. The nine sections into which the work is divided discuss in this order: General Features of Gravimetric Processes, Gas Evolution Processes, Precipitation Processes (includes electrolytic methods), Solution and Extraction Processes, Partition Processes, General Features of Volumetric Processes, Processes Involving Precipitation, Involving Neutralization and Displacement, and Involving Oxidation. These sections are subdivided into chapters which treat the general theory, sources and extent of errors, and the laboratory work.

The major points of difference between this text and the usual texts on quantitative chemistry is the well placed, although unusual, attention to the theoretical details and the accuracy of the methods. The laboratory determinations are described completely in theory and manipulation, often illustrated by diagrams. The author's choice of title amply describes its scope which includes more processes than most such texts. Altogether the book is well written, well printed and should prove very suitable for the purpose for which it was intended. N. F. G.

Practical Flight Training. By LIEUT. BARRETT STUDLEY, U. S. N. *The MacMillan Company, New York, 1928. 429 pages, 160 illustrations. Price $5.00.*

This volume is written primarily as a reference textbook for students beginning their flight training. Its subject matter has been compiled and arranged so as to be of maximum benefit, based on Lieutenant Studley's experience as an instructor at the Naval Air Station at Pensacola, Florida. It is not a proposition of "Learn to Fly — in one volume"; it is intended as a manual to be used in conjunction with a regular flight training school course. Much general material, such as Department of Commerce regulations, has been added, and material which would be of strictly naval interest has obviously been omitted. It is well written in understandable and largely non-technical language. Paragraphs throughout the book have been titled and numbered, and frequent outlines given. In an effort to illustrate the right and the wrong way to do things, good photographs of modern equipment are freely used. These are aided by clear drawings of procedures, etc.

The book covers the handling of heavier-than-air craft, both landplanes and seaplanes. The first ten chapters are devoted to discussions of general flight problems, flying course procedures, personal qualifications, and an excellent discussion of the question of safety in flight training and precautions to be taken.

In Part III, Elementary Flying, simple maneuvers are taken up in order, and a detailed chapter is devoted to each. Taxying, Turns, Landings, Stalls and Spins, and The First Solo, are among the chapter headings. The paragraphs cover each variation of the maneuver and the chapters generally end with a discussion of common faults and safety precautions.

In Part IV, advanced flying is covered through acrobatics, night flying, formation work, cross country, and navigation. This advanced flying is treated in the same manner as before, but not in such detail. The remainder of the volume is devoted to a good discussion of the flying school, its system, organization, and the arrangement and conduct of flying courses. There is a section for the instructor himself with suggestions as to how to be of most help to the student. A bibliography, nomenclature, and glossary of common terms heard in connection with airplanes is appended.

The book is well arranged, modern, and written by an officer who is thoroughly familiar with his subject. If the reader expects to be able, on having completed the volume, to step into a cockpit and qualify for a pilot's license, he is likely to be disappointed. However, if he desires a book of valuable reference, one which can give him an advance idea of the situations which he is likely to encounter in the air, he will find its study well worth while.

J. C. R.

General view of the United States Military Academy, West Point, N. Y.

PROBABLY no single spot in this country is more widely known than West Point, where our future army commanders receive their education and training in the arts of war.

As an army post in the Revolution, West Point's fortifications were the works that Benedict Arnold attempted to deliver into the hands of the British. Later the United States Military Academy was established and is now composed of magnificent buildings, parade grounds and athletic fields.

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Valuation Engineering

(*Continued from page 58*)

jumps you arrived back at the starting point. In regard to the earnings under rates fixed by law, the sufficiency of these was also entirely dependent upon value, so that you returned to the starting point in one jump. This left, then, original cost and reproduction cost as the two factors which represented the high limit and the low limit respectively. Since the rise in prices from 1914 to 1920, the positions have been entirely reversed and reproduction cost is now the high limit and original cost the low limit, in most cases.

The reproduction cost new is now generally taken less depreciation. Owing to the difficulty in many cases of finding the original cost, this is often replaced by what is known as historical cost. To find historical cost, an inventory is made up at some pre-war date, such as 1914, of the property in existence at that time, which inventory is then priced with prices which are considered an average, or to be typical of, that date. The cost is then brought down to date by the use of the net additions, generally taken from the books. The low limit is sometimes lowered by deducting depreciation from the original or historic cost. With the very notable exception of the Interstate Commerce Commission, there has been in recent years a steady trend towards reproduction new, less depreciation as a measure of value for rate making purposes. Where commissions do not base their value on reproduction new, less depreciation, they generally give it a very decided weight.

The problem then arises of determining reproduction new and reproduction new less depreciation, and at this point the valuation engineer enters.

There are two principal methods of determining the cost to reproduce a property. The first is for the engineer to set up from his judgment, backed, of course, by his experience, the amount required to replace the property, under the theory that all conditions are those of the present day except that the particular utility does not exist. The reproduction cost of the property is thus estimated under modern conditions. In reproducing, for example, a street railway, though the excavation of track was originally made with pick, hand shovel, and dump carts, it may now be estimated to be made with power shovels and trucks. The engineer's estimate, in many cases, will practically parallel and be equal in detail to the one which he would make for a contractor about to bid on similar work, with one great difference, that it is probable that the contractor would include much larger percentages for omissions and contingencies than are generally allowed in valuations.

After this estimate has been made, there are added certain costs known as construction overheads. These consist of such items as 5 per cent for engineering and superintendence, of sums for taxes and insurance during construction, and sums for other expenses which would be incurred if the property were to be reproduced over a period of two, three, or four years. These construction overheads are an actual part of the cost of the property and are as necessary for its reproduction as the actual labor and material which are frequently referred to as the "barebones cost." The valuation engineer should have a firm basis for his costs and must be prepared to defend them against a very sharp attack. Experience in construction and dealing with men and materials is a help.

The other principal method of finding reproduction new cost, or present undepreciated value, is by the use of an index. There are many methods of making an index, such as by the use of the geometrical or harmonic mean, the median or the mode. However, the index principally used in valuation work is based on an analysis of the cost of the elements of the structure in question in the year used as a base, treated in the following manner: The same quantities of the elements, both labor and material, are priced in each year or month for the period in question and the indicated costs of the structure thus found are divided by the cost in the base year and the results of these divisions form the index. For instance, the writer was once asked to check the valuation of a wooden pier. From experience, it was known that in this particular piece of work, the piles in place, the structural timber, such as 12 x 12 and 4 x 12 Georgia pine, and the labor of dock carpenters were approximately equal in cost in the year it was built. Having the typical cost of these three elements in the year the pier was built and in the year of the valuation, it was possible to compile immediately a simple index which gave the relation between the cost of the pier when built and its probable cost to reproduce today. In this particular case the results obtained by applying this index to original cost checked the detailed estimate within less than one half of one per cent. This is, of course, much closer than there was any right to expect.

The principle involved in constructing engineering indices may, perhaps, best be illustrated by following this simple case through and constructing an index for it. Every dollar of 1914 pier cost of this particular type represented approximately thirty-three and a third cents worth of labor, thirty-three and a third cents worth of piles in place, and thirty-three and a third cents worth of structural timber. There is given in the preceding table the trend of the cost of these

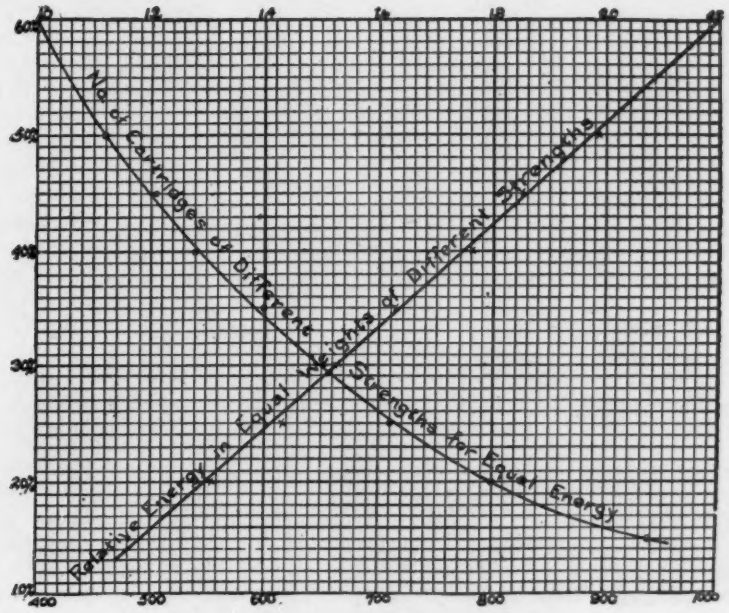
(*Continued on page 68*)

COST INDEX FOR WOODEN PIER, WHERE THE COST OF TIMBER, LABOR ON DECK, AND PILES IN PLACE, ARE EQUAL IN BASE YEAR

Year	*Structural Timber*		*60-Foot Pile in Place*		*Dock Carpenters*		*Index*
	Trend	*Cost of Elements*	*Trend*	*Cost of Elements*	*Trend*	*Cost of Elements*	
1914	100	33 plus	100	33 plus	100	33 plus	100
1915	92	30	111	37	100	33	101
1916	119	36	111	37	100	33	106
1917	167	56	117	39	203	68	163
1918	237	79	117	39	203	68	186
1919	209	70	133	44	203	68	182
1920	250	83	167	56	203	68	207
1921	209	70	161	54	203	68	192
1922	226	75	156	52	203	68	195
1923	242	81	153	51	203	68	200
1924	231	77	153	51	203	68	196
1925	234	78	150	50	203	68	196
1926	226	75	150	50	203	68	193
1927	218	73	150	50	203	68	191
1928	218	73	150	50	203	68	191

The above trends are based on actual costs for this particular location. For instance, dock carpenters received 34 cents an hour until 1917, since when they have received 69 cents. Most labor has shown a greater variation and in many cases a much greater rate of rise, sometimes to as much as triple pre-war, but this example has been selected because it is both real and very simple. This index shows a drop since 1923 but this has not been a general tendency.

Action of Explosives


No. of Cartridges of Different Strengths Required to Equal Energy
Relative Energy in Equal Weights of Different Strengths
Strengths for Equal Energy

Lesson No. 1 of

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ALL explosives are solids or liquids that can be instantaneously converted by friction, heat, shock, sparks or other means into large volumes of gas. That sounds simple, but this fundamental principle of the action of explosives is modified by a host of circumstances.

First there are "high" and "low" explosives. Then there are all the circumstances of purpose, methods of loading and firing and handling and storing. Explosives are measured principally by these general characteristics: **Strength, Velocity, Water Resistance, Density, Fumes, Temperature of Freezing, and Length and Duration of Flame.**

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Valuation Engineering

(*Continued from page 66*)

three elements based on the actual cost, with 1914 as a base year, and the amount of money that this item would have cost in each of the succeeding years. For instance, dock carpenters received thirty-four cents per hour in 1914 (do not confuse with thirty-three plus which is one third of the 1914 dollar) and they received sixty-nine cents per hour in 1928, therefore, the same hour's work which cost thirty-four cents in 1914 would cost sixty-nine cents in 1928.

The elements and index are shown graphically on Chart 2.

By the use of this index we find that the pier which cost $10,000 in 1914 will cost $19,100 in 1928. It would be better, perhaps, as an illustration, had some weights been used which were not equal, but this index is the simplest one that the writer has ever constructed and it is desirable that an example should be practical.

With Mr. W. W. Pagon '07, the writer once constructed an index for the Efficiency and Economy Commission of Baltimore, which was used to find the present-day value of the bridges of that city in order to write that value on a new set of municipal books. The weights of that index are given below.

WEIGHTS USED IN COST INDEX OF CITY BRIDGES OF BALTIMORE

Piles in place	10.0%
Cement	11.3%
Sand	2.3%
Gravel	6.7%
Stone aggregate	1.5%
Building stone	4.0%
Bridge and form timber	13.4%
Common labor	13.4%
Form carpenters	6.1%
Bridge carpenters	4.0%
Masons	6.5%
Structural Steel:	
Material	7.0%
Labor	8.0%
Reinforcing steel	5.8%
	100.0%

(The index based on these weights was published in *The Annalist*, June 29, 1928.)

The most widely known index of prices is not a construction index but is one of wholesale prices. It is constructed and issued monthly by the United States Bureau of Labor Statistics of the Department of Labor. This index is based on the value of all of the manufactured products listed by the United States Census together with the agricultural products of the country. This value is the base. The same amount and variety of goods are then priced in each year of a period of years and the results divided by the value of the base year give the index. Although this index is the most widely known and used, it will differ from a construction index because of the fact that labor has increased out of proportion to commodities, and although the Bureau of Labor Index is now about one and a half times its 1913 base figure, the construction indexes today are practically double or over their base years.

The foregoing discussion may seem to give rather undue weight to indices, but they are becoming of greater importance all the time and it is felt that the reader might desire some knowledge on the subject.

With the use of a good construction index and the original costs, and the dates thereof, an accurate present-day value estimate may be very readily made up by one who understands the construction problems of the type of property involved. Whether construction overheads will be placed on the value found by an index or not rests on the method of keeping the original entries; if they had sufficient overheads, which is seldom the case, then the index will automatically take care of the construction overheads.

When it comes to depreciation, we have again a high limit and a low limit. Those who work for a low valuation, generally present a depreciation study based on "life tables" or "mortality tables." These tables are supposed to follow the lines of the life insurance company tables, in which the lives of a large number of persons are studied, and tables and curves made from which the length of life or "life expectancy" may be predicted. The most highly developed of these are based on equations and curves involving logarithmic functions. It was once testified about one of these curves that two persons with calculating machines could work one out in a day. Those who work for the low limit claim that the remaining life can be predicted and that the value is dependent on that life.

Against this argument it is urged that by proper maintenance the life of most property can be prolonged indefinitely, as far as wear is concerned, and that the very large majority of property is retired because of obsolescence or inadequacy which no one can foresee. It is urged, for example, that a gas main suffers practically no wear due to use or the lapse of time and that as long as it is adequate, it has no depreciation; that if it must ever be retired, its retirement will be due to inadequacy which generally takes place without warning and cannot be predicted; and that, therefore, an active and well maintained property has an indefinite life and is in one hundred per cent condition.

The Supreme Court of the United States, which has the last word on all valuation matters, has said, in the famous Indianapolis Water Case: "The testimony of competent valuation engineers who examined the property and made estimates in respect of its condition is to be preferred to mere calculations based on averages and assumed probabilities"; so that depreciation, as well as the estimate of reproduction new, is the province of the valuation engineer.

The foregoing may seem to be a somewhat rambling discourse which covers both law and engineering, but it may serve to furnish the young engineer with a rough outline of some of the problems that are embraced in that division of the profession known as valuation engineering.

A Short Wave Vacuum Tube has recently been developed which operates on a wave length of six meters and has proved to be fifty times as powerful as other short wave tubes. With the increasing importance of short wave radio it will have many applications.

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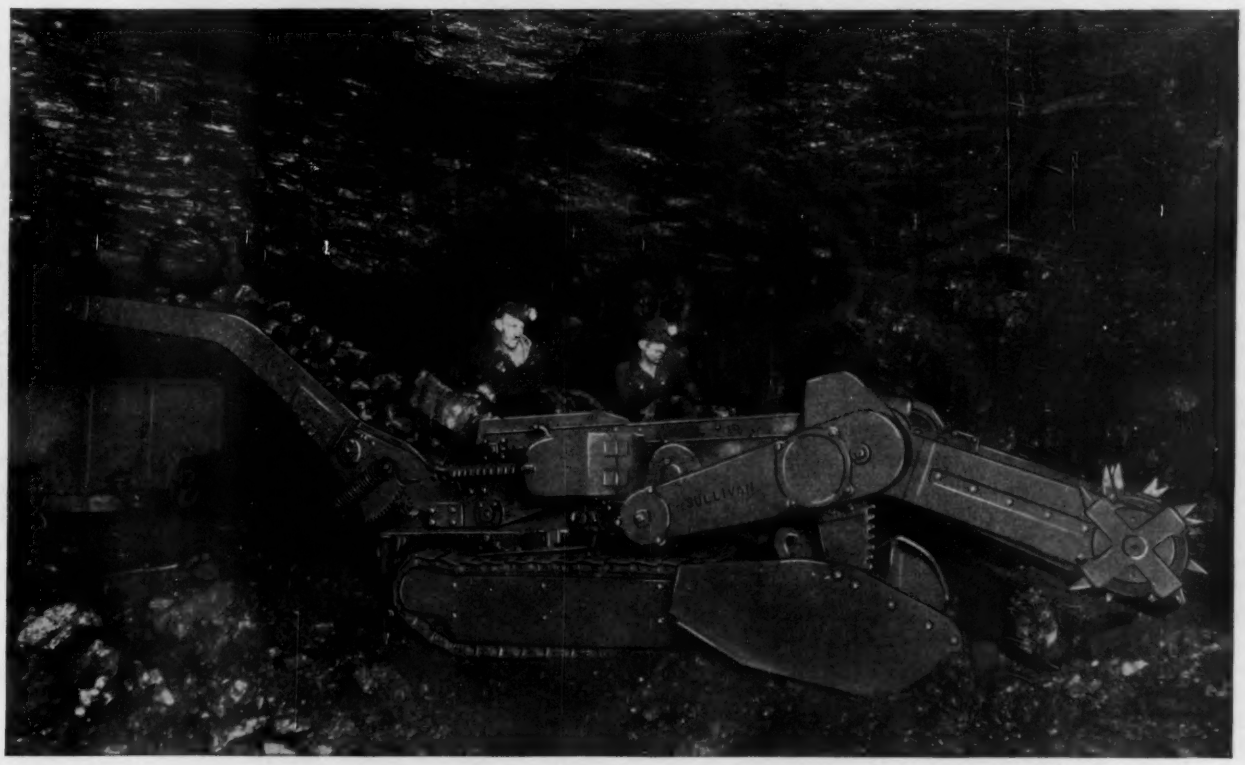


Sullivan Coal Loader handling a run of large lump coal

The Modern Dinosaur

—a beneficent monster that wars on coal mine costs

The new Sullivan Coal Loader is a giant in power and speed. But it responds quickly to sensitive controls. It moves steadily to the working place, opens great jaws to gather up coal, and swings its steel tail to load the cars —with only two men to guide it.

Primarily, the machine consists of a shovel plate, with a bit-studded roller, and two conveyors. It is equipped with a substantial frame, and crawler traction.

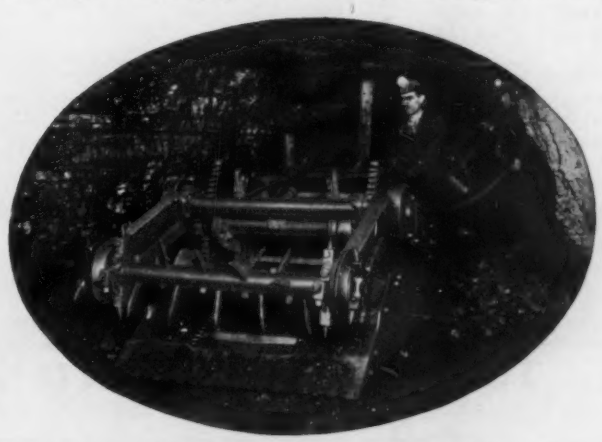
Each digging, conveying, and moving member is independently controlled. The machine forges its own way into the pile, and the coal is pulled by the roller, onto the conveyors which deliver it to the cars in the rear.

These loaders will handle 200 to 300 tons in an 8-hour shift.

Sullivan Coal Mining Equipment has pioneered for more than a generation, in improving mining efficiency.

Catalogs on Loaders, Coal Cutters, Diamond Core Drills, Air Compressors, Rock Drills, and Hoists will be sent free to engineering students, on request.

Ask also for the booklet outlining your opportunities if you should join the Sullivan organization.



Closeup of the loader passing through a break through

SULLIVAN MACHINERY COMPANY, 164 S. Michigan Ave., Chicago

SULLIVAN TRADE MARK

Departmental Notes

(*Continued from page 62*)

of management is whether or not to scrap old machinery and replace it with new machinery of higher efficiency. Prof. C. H. Porter has given some attention to the accounting features of this problem through the application of mathematical analysis.

During the past few weeks the department has had two stimulating meetings of advisory committees, one being held in Boston and the other in New York. At each of these, business men of wide experience as well as some of the younger graduates of the course participated in the discussion of possible improvements in the curriculum of instruction. Although those present at each of these meetings hold positions of business responsibility rather than engineering practice, there was a general agreement that an engineering education for business purposes was of the greatest value, inasmuch as it taught students how to think accurately, and there was an equally general agreement that the course should retain a generous amount of courses in science and engineering.

Professor Schell has been making some interesting inquiries of the graduates of the course through questionnaires. He has secured salary figures for more than half the members of the classes from 1919 to 1924. Salary figures obtained in this manner have to be interpreted with care. Presumably they do not include salaries of the very lowest rank or the exceptionally high salaries. Graduates who for one reason or another — illness, travel, or possibly unfortunate start — and graduates who may, through family connections, have been given especially favorable opportunities, may not report. The figures also do not include unearned income, but are strictly confined to salaries.

An interesting point to notice in this is the fairly uniform increase from year to year. In some cases individual salaries which are below the average during the first few years reflect periods of personal investment in experience which produce greater accelerations in wage during the later years. Opportunities for transfer also from one position to another during the early period may result in wage advances which brought returns above the average, after which a period of stabilization is to be expected.

The interesting point to note in the table below is that a very considerable number of the men have worked up from apprenticeship to executive positions. It is also to be noted that a considerable number have retained their interest in technical engineering work, and apparently have not been handicapped by the fact that a somewhat less amount of engineering work has been given in this particular course.

For the first time this year the department is giving a course in contracting management to students in the course of Building Construction (XVII).

DAVIS R. DEWEY.

	Class of					
Upon	*1919*	*1920*	*1921*	*1922*	*1923*	*1924*
Graduation,	$1,680	$1,555	$1,500	$1,550	$1,595	$1,420
First Year	2,240	1,810	1,770	1,920	1,940	1,860
Second Year	2,800	2,210	2,300	2,640	2,310	2,380
Third Year	2,770	2,700	2,880	3,025	2,780	3,190
Fourth Year	3,015	3,305	3,220	3,500	3,480	
Fifth Year	3,610	3,610	4,005	4,270		
Sixth Year	4,450	4,400	4,500			
Seventh Year	4,900	4,830				
Eighth Year	5,120					

	'21–'22	*'22–'23*	*'23–'24*	*'24–'25*	*'25–'26*	*'26–'27*
Executive work in finance, sales and production	6	8	11	16	19	25
Functional specialists in finance, sales and production	16	26	25	23	17	15
Apprenticeship work	26	4	2	1	..	..
Salesmen	4	7	6	5	8	8
Technical work	8	13	17	16	15	12
Educational work	5	5	3	3	4	2
Required military service, foreign students	1	1	..	..	..	..
Unknown	4	5	5	5	6	7
Died	..	1	..	..	..	..

American Railroads

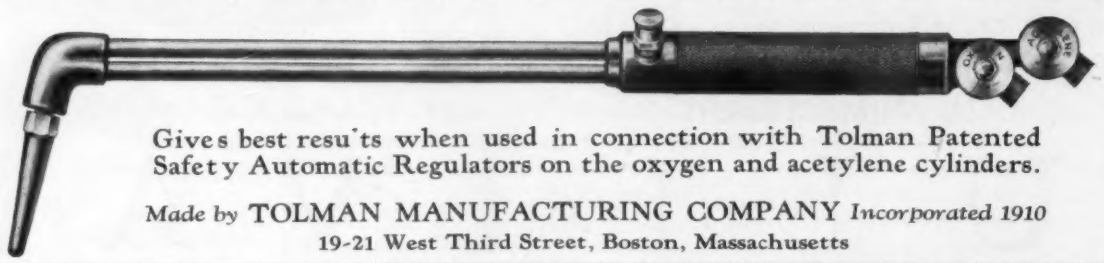
(*Continued from page 52*)

More than 6 per cent of the total operating revenues of the carriers are consumed by taxes, which actually means that of every dollar paid by the public for passenger or freight service, six cents is paid in taxes, and the railroad gets only 94 cents. Viewed from another angle, we find that out of the gross revenue of an entire year, it takes on the average, the receipts of 22 days for taxes.

Approximately three-fourths of the 395 million dollars taxes which the railways paid last year went to state and local governments. Unfortunately, State debts are not decreasing, but increasing. The advance during 1927 was 125 millions, or 6.7 per cent, according to the most recent figures.

American railroad rates are not high, but even if they were a great deal higher than they are now, they would be low beside the cost to the traveling and shipping public of a breakdown in our transportation machine. It would be helpful to the transportation industry if there were a greater realization on the part of the public that rates are, in essence, an investment in transportation, and the quality of this transportation is usually in direct proportion to the rate paid. What the shipper must have in this age of heightened competition is the most efficient and economical transportation he can secure. A more general appreciation of the fact that the cost of poor service is so much greater than any saving in rates could possibly be, would go far towards solving the entire rate situation.

TOLMAN WELDING AND CUTTING TORCH



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Made by TOLMAN MANUFACTURING COMPANY *Incorporated 1910*

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L. J. CAHILL,
Lighting Engineer,
U. of Akron, '26

R. W. BUSH,
Commercial Lighting Specialist,
Los Angeles Office,
U. of Southern California, '24

YOUNGER COLLEGE MEN
ON RECENT WESTINGHOUSE JOBS

H. E. LIPPMAN,
Lighting Engineer,
Penn State, '25

I. A. YOST,
Lighting Engineer,
Penn State, '24

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Lighting Engineer,
Notre Dame, '18

JAMES D. REID,
Lighting Engineer,
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The Mines Field Illumination

Where do young men get in a large industrial organization? Have they opportunity to exercise creative talent? Is individual work recognized?

MINES FIELD, Los Angeles, is famous as the scene of the 1928 International Air Races and Aeronautical Exposition. Equally famous among flyers is the perfect illumination which enabled pilots on the night programs to land with all the ease and assurance of those who did their flying by day.

To blanket the field with brilliance and yet avoid dangerous glare was the problem assigned to the Westinghouse engineers who designed the Mines Field lighting for this greatest of air meets. Twenty-one huge floodlight projectors, each with a maximum beam candlepower of one million, provided the brilliance. An ingenious system of louvres cutting off upward rays of light provided protection from glare. The result was an achievement in airport lighting which has been pronounced the most nearly perfect of any in the United States.

The outstanding jobs go to organizations with the resources and facilities to handle them. Westinghouse, because of the outstanding opportunities which are of almost daily occurrence within its organization, offers strong attractions to young men of enterprise and ability.

Westinghouse

The Autogiro

(*Continued from page 54*)

bearing and the secondary articulation a plain bearing. The secondary articulation was not at first used, but was adapted as the result of experiments carried out with the purpose of relieving alternative stresses in the plane of rotation. In 1927 an accident had occurred as a result of these stresses, one of the blades failing in the air at its root. The machine came down quite slowly nevertheless, due to the support of the other three blades. Due to the accident experiments were carried out on the ground with blades set up on a testing tower and set in motion by the wind. After the experiments the second articulation was added, set perpendicular to the original one, in such a way that the blades were free to alter their relative angular positions within certain limits. The interbracing necessary to limit these movements gave quite a good deal of trouble, but the second articulation showed itself to be a solution of the trouble from alternative stresses.

The Autogiro is extremely stable due to the system of hinging the wings and their rotary motion. In the Autogiro any difference of lift on any point outside the central shaft is taken up by the movement of the wing up or down on the hinge so that all of the lift forces have to pass through one point at the center and thus complete stability is obtained. The Autogiro in common with the aeroplane obtains its support from the relative motion of the supporting wing surfaces and the air. The difference is that while the aeroplane in order to obtain enough support has a definite minimum translational speed, the Autogiro, through the relative motion of its supporting surfaces in rotation, obtains support even while the machine as a whole has no forward velocity, and consequently the Autogiro has no definite minimum translational speed of support. It is therefore capable of vertical descent, and can land within a small space and without a run. In actual practice the Autogiro is generally landed with a very slow landing speed, but it can be landed vertically with no danger to the passengers. In the models now in use, in taking off it is first necessary that the blades revolve at eighty per cent of the normal flight revolutions. To obtain these revolutions the machines are taxied around the field until about half of the normal flight revolutions are obtained, then headed into the wind and the throttle opened. As soon as the eighty per cent necessary for support are obtained the machine takes off. The normal rotor revolutions in flight for the Cierva Autogiro "C. 8. Mark III" with a 180 h.p. LYNX engine is 115 r.p.m.

It is planned to equip the Autogiro with a mechanical self-starter for starting the wings in rotation so that taxying can be avoided. This mechanical starter would be used solely for attaining the required eighty per cent of the normal flight revolutions, and would cease to function as soon as they are obtained. When machines are so equipped, it will be possible for them to take off almost vertically from any small plot of ground, and the operator will not be limited, as he is today, to large landing fields. The Autogiro today can take off from fields much smaller than those required by the ordinary aeroplane, by taxying around the field and thus obtaining its required number of revolutions as explained before.

In flight, the Autogiro is controlled in the same manner as an ordinary aeroplane, except that the forward speed can be cut down without fear of a stall. Should the motor cease to function the Autogiro remains controllable, and can be glided down to

(*Continued on page 74*)

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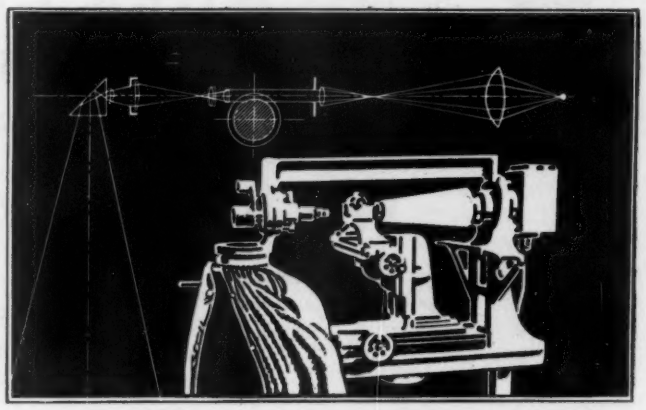

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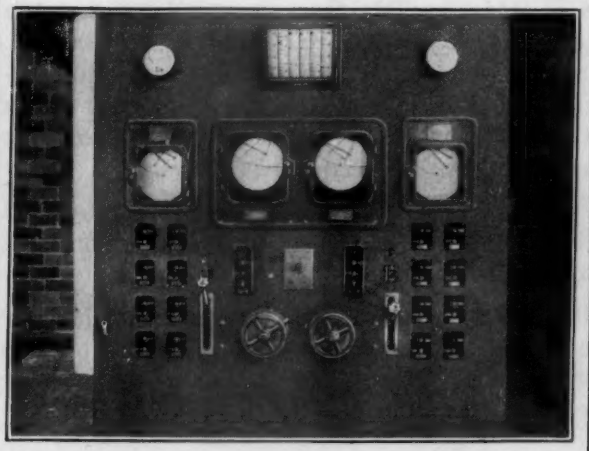

Bailey Meters on a Pulverized Coal Fired Boiler

Fig. 651, Flanged, Jenkins Standard Iron Body Gate Valve

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Goals in basketball are seldom the result of chance. A high degree of accuracy is called for.

Accuracy counts for as much in manufacturing and the making of Jenkins Valves is a good example. Accuracy enters into every operation from the choice of metals by competent metallurgists to the rigid testing of the finished valves.

Castings for Jenkins Valves are sound and flawless, inspection systematic and constant. Machining is precise, assembly painstaking.

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Jenkins
VALVES
Since 1864

The Autogiro

(*Continued from page 72*)

any nearby plot of ground, and when above it, descend almost vertically into it. In taking off from the ground, if the motor should stop, and not enough altitude had been obtained to clear obstructions around the field in the case of an ordinary aeroplane, a stall and a sudden dive to the ground would be very likely. With the Autogiro, the forward velocity can be cut down by pulling the stick back, and a vertical descent made in safety, and under control.

Because of the slow landing speed, it has been found best to use a wide landing gear. In the Cierva Autogiro Mark II a skid is incorporated with the regular aeroplane landing gear. A new model, the Mark III, has been developed in which the skid type is displaced by one with a split axle and radius rods. Oleo and compression rubber legs are used.

The mast is attached to fuselage structure by means of four steel tube struts, which take the load. The lower end of the mast is attached to a traversing gear, which consists of a worm and nut, operated by a hand wheel in the front cockpit. This enables the pilot to control the lateral angle of the mast, that is, the angle of the axis of the rotor, displacing the whole of the lift action to one side or the other of the center of gravity, and so modifying the lateral balance of the ship.

The Mark III, equipped with the Armstrong-Siddeley "Lynx" IV engine of 180 h.p., gave the following performances on a test made on a model sold to the Italian Government:

Maximum speed, sea level, 105 mi.p.hr. at 2,000 r.p.m.

Cruising speed, sea level, 85 mi.p.hr. at 1,800 r.p.m.

Minimum speed, sea level, 25 mi.-p.hr.

Minimum speed (gliding), 15 mi.-p.hr.

Climb, 700 ft. p.m.

A light Autogiro has also been developed with a "Cirrus" Mark III engine using a standard Avro-Avian light plane fuselage. With this motor the performance is as follows:

Maximum speed, sea level, 90 mi.-p.hr.

Minimum speed, sea level, 28 mi.-p.hr.

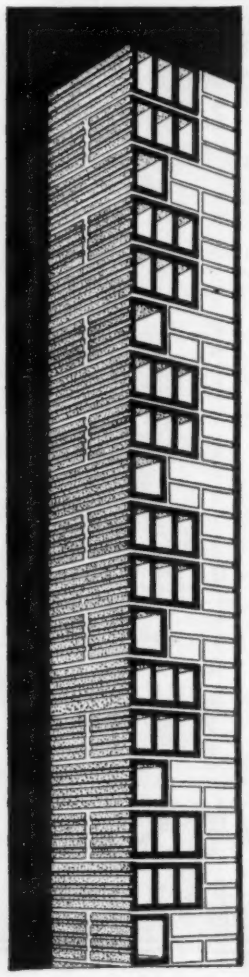
Cruising speed, sea level, 70 mi.p.hr.

Rate of climb, 300 ft.p.m.

Duration of flight, about 3 hours.

The development of this type of plane seems to give promise of an aeroplane which can be safely used by the average man as well as the skilled pilot, and which can be used in the small space available for taking off and landing which the average man has at his disposal. Flying has been hampered in the past by the fact that quite a definite degree of skill is required on the part of the operator, and by the limited quantity of fields available, as well as by the fact that in many cases the fields which must be used with the ordinary aeroplane are often at a considerable distance from the final destination of the flyer, who needs must continue his journey on the ground. A large degree of success has already been attained by the Autogiro, some long distance flights have been made, and its further development is mainly a matter of refinement. It is not at all impossible that the Autogiro may one day become more popular with the average man than is the conventional airplane of today.

EDITOR'S NOTE: This article on "The Autogiro" was prepared by Mr. Berghell from original data furnished by the Cierva Autogiro Company, Ltd., and the A. D. C. Aircraft, Ltd., London, England. The photograph of the Autogiro in flight was furnished by the Newcastle Aero Club and North Mail.



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Load-bearing walls and partition walls of Structural Clay Tile are efficient barriers against heat or cold, sound, moisture and fire.

The flexibility and permanence of Structural Clay Tile commend it for the execution of architectural design of infinite variety. Its economy makes it practical for all types of construction.

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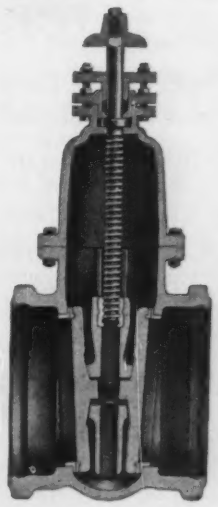
THE "MATHEWS" FIRE HYDRANT dates back to the late sixties, when Hydrants were largely the product of local foundries and the designs many and varied.

"MATHEWS" immediately gained favor and rapidly became the STANDARD for COMPARISON.

Today, with over three hundred thousand in service, it occupies first place, and the long list of users is constantly growing.

Our long experience has brought steady improvement in the details of construction, but because of the fundamentally sound principle there has been no radical change in the essential features of design. Correct design and substantial construction account for the success of the "MATHEWS" Hydrant.

We extend an invitation to all interested students to visit our extensive plant to observe the manufacture of "MATHEWS" Hydrants, and our other products.



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R. D. WOOD & COMPANY

Engineers, Iron Founders, Machinists

PHILADELPHIA, PENNSYLVANIA

Increasing Recognition for the Engineer

(*Continued from page 55*)

doing engineering work could classify themselves as engineers in distinction from men engaged also in the work of other professions. The Massachusetts Institute of Technology itself was founded only in 1859 and incorporated in 1861, barely seventy years ago, and most other technical schools are of even more recent date. Undoubtedly many men prominent in public life in past history, who possessed minds of engineering ability, and who might have definitely followed engineering careers if they had lived in the present generation, did not do so in the days when they lived and never called themselves engineers because there were fewer opportunities then for ambitious men in engineering and related work. One suspects in reading history that many men whom we remember now for their attainments in other fields of endeavor might have been remembered even more favorably had they enjoyed a fuller opportunity during their lifetimes to develop as engineers. Julius Caesar, for instance, remembered now chiefly as a soldier and statesman, wrote so carefully and interestingly about his bridge across the Rhine that he must have had a strong leaning toward engineering. Leonardo da Vinci, Michael Angelo, and other great men of the Renaissance, remembered now chiefly as painters or sculptors, handled also engineering problems of their time with ingenuity and skill and might have developed further their engineering abilities had not the public of that time and its leaders, patrons of their art, been more interested in giving substantial recognition to their artistic productions.

Today, public standards and the elements of public esteem have changed and the engineer, as such, is beginning to come into his own. The general public has had the opportunity, for the first time in history, over the last fifty years or so, to judge of the results of the lives of technically trained men who have devoted practically all their years to the pursuits of applied science, which, for the purposes of this article at least, are lumped under the general classification "engineering." In the last fifty years, the general public has had given to it, as results of the work of engineers, the automobile, the radio, the telephone, the electric light, better roads, bridges and railroads and countless other engineering helps to human comfort and happiness. The public heartily approves and would like to have more along the same lines. Inevitably, with the public approval of the results, comes also public approval of the men who, in groups and as individuals, have made these results possible. Engineering and engineers are esteemed by the general public now as never before in history. Such increasing public recognition for engineers will tend to draw more and more young men (and perhaps more young women, too), of high ability and ambition, into engineering work of the future. All of us are susceptible, in greater or less degree, to the applause or condemnation of those with whom we have to live. During the hundreds of years when the world was reverencing and applauding its military heroes, Alexander, Hannibal, Napoleon and their like, many ambitious young men, day dreaming to themselves from time to time, must have kept imagining themselves as future great military leaders also. Who knows what boys are dreaming today instead of becoming a future George W. Goethals, Thomas A. Edison or Herbert Hoover? If enough promising and ambitious boys will dream such

(*Continued on page 78*)

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NEW MALLORY HATS FOR SPRING

Choice Black Dawn (Gray) or Monaco Burl (Brown) shades at $7.50.

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NEW MODEL
MALLORY BLACK DERBY
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Look at your hat—Everybody else does.

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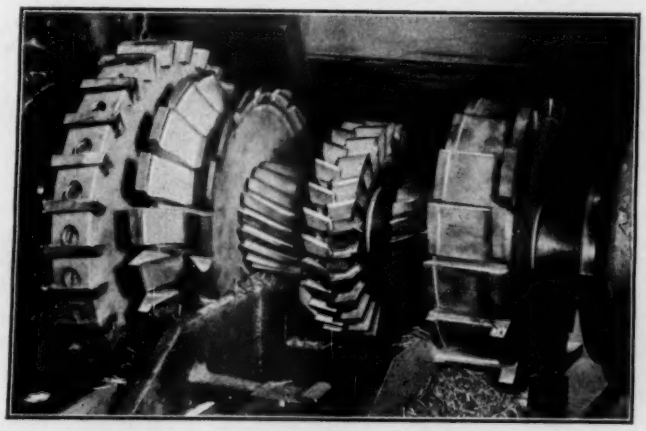
save time and money when you figure real cost



"IT ISN'T the first cost, it's the upkeep." Everyone has heard this statement applied to automobiles. The reasoning is just as sound when applied to the cutters, such as those illustrated, which are used on machines for milling and other forming operations throughout the metal working industry.

A good cutter requires fewer sharpenings than an inferior cutter. During the period of removing, sharpening, and replacing cutters the cost of lost production enters. Brown & Sharpe Cutters keep the lost production cost down to a minimum and, what is most important, they permit a considerable saving in the lost time of expensive machine equipment.

It is not the first, but the real cost—the first cost plus "upkeep"—that determines the economy of a cutter investment.

It profits the manufacturer to take this view when buying equipment, and as a result, more and more are specifying Brown & Sharpe Cutters.

BROWN & SHARPE

BROWN & SHARPE MFG. CO. PROVIDENCE, R. I., U. S. A.

Artificial Earthquakes

High explosives have been the tool of scientists and engineers ever since Alfred Nobel toiled in his laboratory to produce dynamite which he invented in 1867.

Among the immensely varied uses of Hercules Explosives to the scientist and engineer is that of creating artificial earthquakes. The geological structure of the earth's crust may be logged by data from these waves or quakes.

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In the September 1928 issue of The Explosives Engineer magazine there is a very interesting and instructive article describing the methods of prospecting for oil by creating artificial earthquakes with explosives. Upon request, we shall be glad to mail you a free copy of this number.

2545

Increasing Recognition for the Engineer

(*Continued from page 76*)

dreams today, the realizations of their dreams may follow tomorrow. Increased public recognition for engineers now will stimulate greater engineering achievements by other individuals in the future.

One of the most attractive and striking features in the façade of the new Massachusetts Institute of Technology buildings in Cambridge is the inclusion of the names of various celebrated engineers and scientists carved prominently in stone and conspicuous to all who approach the buildings. More could be done in the way of other memorials in the interiors of the several Institute buildings to honor further the great achievements of many other engineers of the past, now dead. A couple of years ago it was my privilege to visit the great German Museum in Munich, an enormous technical museum which as yet has no equal, but ought to have, in this country. I was particularly impressed with the care taken in this museum, by statues, busts, and appropriate mural inscriptions, to glorify great individuals of the past, from many different countries, who have contributed toward the advancement of engineering and science. A great soldier who dies fighting for his country in a noble cause is entitled to have his name perpetuated with imperishable honor. But there are far too many statues in the world of soldiers and political rulers (not all of whom lived nobly) as compared to memorials of constructively minded men like engineers. Young minds especially respond to emulation; many able men work for glory as much as for other motives. The more we honor now and recognize publicly in this generation engineers, the more likely we are to have even better engineers in the next generation. Occasional public engineering awards, like those of the John Fritz medals, are helpful for such purposes.

All successful engineers must have constructive imagination. Doing engineering work also requires and further develops clear thinking and the kind of reasoning that eliminates the irrelevant and cuts directly down to the essentials. When an engineer is making a survey, building a skyscraper, or designing a piece of machinery, one foot four and one-half inches means exactly one foot four and one-half inches, and not more and not less. Baffling political problems may be helped toward solution by more searching intelligence brought to bear upon them by engineers accustomed to exact and successful thinking. The world does not need so much today new statements of ideals as it does need more efficient leaders competent to carry out into actual practice ideals which have many times already been adequately stated. The ideals of men living together in a world of happiness as expounded by Jesus Christ and Marcus Aurelius were not far different from those explained by Buddha and Confucius, and not far different from those of competent modern ethical thinkers. The less important ideal of men flying like birds, which countless millions of men had dreamed about for thousands of years, was not too difficult of actual realization for Langley and the Wright Brothers to bring about. Engineers are accustomed to taking blue print ideals, just paper products of the imagination, if you will, and translating them into realities of steel and stone. Who is there that dares to prophesy limits to the practical achievements in the future of constructively minded engineers, accustomed to accomplish the difficult, if they are given opportunities of leadership in the coming generation to help in solving problems of political and human relationship, the practical

(*Continued on page 80*)

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Increasing Recognition for the Engineer

(*Continued from page 78*)

and lasting solution of which will add so much to the happiness of every one in the world?

We come back, in conclusion, to the signal mark of public recognition of the engineering profession which has come through the election of Herbert Hoover as President of the United States. We have every reason to be thankful for the first engineer President of the United States, George Washington; the future will show what results are to come from the Administration of our second engineer President, Herbert Hoover.

Until recently at least, engineers have not had so much to do with politics and other problems of human relations. When one reads the writings of the Greek philosophers, Plato and Aristotle in particular, and remembers the fairly well working Greek city democracies, long since unfortunately perished, one realizes that not very much recent improvement in the handling of politics and other problems of human relations is evident if we compare Plato's theories and the Greek city practices of his day, for instance, with European theories and practices of the year 1914. If the soldiers and lawyers and the orators who have been running the world for so many thousand years could not develop a civilization which would have made the World War impossible, can the engineers do so? Are the next problems for engineering-minded men of the world to face those of the age-long unsolved problems of better human relations? Must a world that knows radio still have to know bayonets?

Predictions are dangerous, and engineers, who spend their time dealing with facts rather than fancies, have no desire to set themselves apart as any class of the elect. It is to be hoped, however, that the increasing public recognition of engineers does not represent misplaced public confidence. There is reason for belief, also, that engineers who have shown their capacities to make so many astounding physical changes for the better in the world today as compared to the world of ancient times, may also show capacities, as and when they are given opportunities, to help in solving along scientific lines the more difficult and more important moral and political problems of men and women living together in peaceful and happy human relations. A great many engineers and other constructively-minded men will have to coöperate together in this; any one individual, no matter how prominently placed, can do but little. It is for this, as well as for other reasons, that so many engineers are quietly rejoicing in the increasing public recognition of their profession, and in such signs of this gratifying fact as the election of engineer Herbert Hoover to the Presidency of the United States. But with this satisfaction must come the full realization that along with such recognition and honor go duty and obligation. No one who really knows and understands engineers believes that they will fail to meet adequately as a class and, almost unanimously, as individuals also, their new and growing responsibilities. Let us hope and trust that increasing public recognition for engineers will have as one of its inevitable and beneficial results an increasing rendering by engineers of altruistic, unselfish public service, in many ways and forms that are much needed today both in our own country and throughout the rest of the world.

Airplane Propellers are being painted in brilliant colors to prevent accidents caused by people running into them. Considering the many fatalities that have occurred from this cause in the past, this innovation should prove to be of great benefit.

The Cascade Tunnel

(*Continued from page 57*)

and carried through to the shaft by May 31, 1928.

The plan of attack between Scenic and the shaft and the relative position of pioneer and main tunnel will be made clear by reference to Fig. 5. The 8 by 9 foot pioneer tunnel was originally laid out on the same level as the center heading, but as work proceeded and heavy water flows were encountered, the level was dropped to facilitate drainage from main tunnel. The pioneer tunnel was located 66 feet south of center of main tunnel.

Much water under pressure was encountered between Scenic and the Mill Creek shaft — the flow at one time reaching as much as 10,000 gallons per minute, and prior to the time when the pioneer tunnel was connected through on May 1, 1928, the pumps at Mill Creek shaft were raising 2,000 gallons per minute.

Instead of a center heading for the main tunnel, much of the work west of the shaft was carried on with top or bottom headings and a great deal of timbering was necessary.

All operations were carried out on a three-shift basis. A maximum of 1,800 men was employed and not a single shift was lost in the entire construction period.

Records heretofore unsurpassed were made in both pioneer tunnel and also in the enlargement, the figures being,

October, 1926 1157 ft. Pioneer tunnel
August, 1927 1220 ft. Full section enlargement

The last of the muck was removed from the tunnel on December 8, 1928, or one week less than three years from the date work started. This remarkable record was accomplished largely through the excellent organization of the contractor and the fine spirit which pervaded the work, but good equipment and an unlimited supply of power contributed to the success of the undertaking. The general plan

(*Continued on page 82*)

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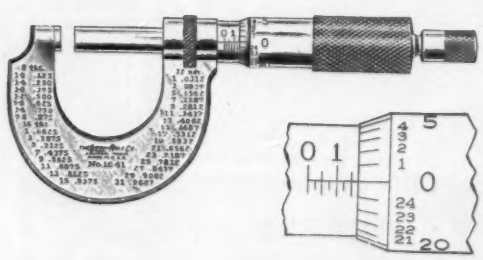
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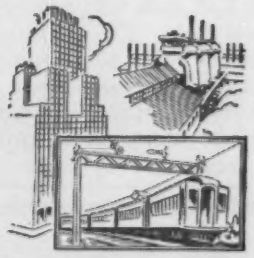

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The Cascade Tunnel

(*Continued from page 80*)

worked out was that until delivery of power over the Great Northern Railway Company's transmission line from the Puget Sound Power & Light Company's system, Diesel engine driven generators were installed which were maintained later as emergency plants. These power plants consisted generally of 360 h.p. six-cylinder Diesel engines coupled directly to generators, the total capacity at Scenic being 1,200 h.p. and at Mill Creek 720 h.p. The generators delivered 2,300-volt, 60-cycle, 3-phase alternating current.

All underground lighting was 3-phase, 60-cycle, 220-volt. Underground haulage was operated from trolley wires carrying 275-volt direct current, motor generator sets being placed at convenient points inside the tunnel for this conversion.

Track in the pioneer tunnel and center headings was 2-foot gauge and the material was loaded by Myers-Whaley electrically driven machines into 50 cubic feet steel side dump cars which were hauled out by 6-ton General Electric locomotives. These locomotives were equipped with reels carrying 500 feet of cable, as trolley could not be carried close to the working faces.

Track in the enlargement was 3-foot gauge, the muck being loaded by 40-ton shovels on caterpillar treads. These shovels were old steam shovels converted to operate with air. The dump cars were 6 cubic yard capacity and were hauled by 20-ton General Electric locomotives.

At the beginning it was thought that the rock might be self-sustaining, but it was soon realized that the character of the rock was such as to require the lining of the tunnel throughout. The finished section is shown by Fig. 6. To carry on this concreting so that it would not interfere with excavation and would be completed shortly after the last rock was removed, was a difficult task. The granite in the tunnel was not suitable for concrete aggregate so that it was necessary to construct a gravel washing and crushing plant at Reiter, Washington, thirty miles west of Scenic.

Sand and gravel were delivered from standard gauge dump cars at Berne and Scenic, at Berne, directly into the proportioning plant, at Scenic, into bins from which it was transferred to 6 cubic yard, 3-foot gauge cars in which it was hauled to the proportioning plant. These proportioning plants consisted of covered bins with a volumetric device on the coarse aggregate bins and a weighing device for the fine aggregate and the plant was so arranged as to permit dumping the sand and gravel in proper proportions for a 1 : 2 : 4 mix into one-half cubic yard batch boxes. Each of these boxes contained a separate compartment for cement which was added after the box had received its charge of sand and gravel.

The distance from portal to the middle of the tunnel was so great that it was necessary to haul the aggregate dry as above outlined and to do the mixing at the point of placing concrete. This was accomplished by using steel collapsible forms 37½ feet long with a platform high enough above the floor of the tunnel to permit free operation of muck trains.

On this platform was mounted a hoist for lifting up the batch buckets, a concrete mixer with device for elevating the mixture to a central bin, spouts leading from bin for pouring side walls and a Ransome air gun which was used to place concrete in the arch. During the latter part of the work eight of these forms were in use and as much as 112½ feet of concrete lining was placed in one day.

The total excavation from the main tunnel was 840,000 cubic yards and 262,000 cubic yards of concrete were placed in lining the tunnel.

The lining was finished on December 24 and in the meantime ties and rail had been hauled into the tunnel. As soon as concreting was finished the dismantling of the forms and the tearing up of the narrow gauge tracks was started at the middle, and as space was made, standard gauge track was put down so that when the tunnel was cleared of narrow gauge tracks the permanent track was available. At the same time the overhead 11,000-volt trolley, the signal transmission and other wires were installed, and track bonded in readiness to begin ballasting, electric locomotives being used for this purpose. The track was ballasted and ready on January 7, and the formal opening took place on January 12, 1929.

The completion of this tunnel and its approaches, at a cost of $15,000,000, together with the Chumstick revision, which cost $5,000,000, has substituted forty-one miles of line having good alignment for fifty miles of old line with poor alignment, higher summit and heavier grades.

The following figures show the comparison:

	Old Line	*New Line*	*Favorable to New Line*
Length of line...	49.98 mi.	41.10 mi.	8.88 mi.
Degrees of curvature.....	5683	2009	3674
Summit elevation	3383 ft.	2881 ft.	502 ft.
Grade in tunnel.	1.69%	1.56%	0.13%
Length of maximum grade...	24.63 mi.	6.37 mi.	18.26 mi.
Rise westbound .	2410 ft.	1889 ft.	521 ft.
Fall westbound..	1402 ft.	881 ft.	521 ft.

President in the Making

(*Continued from page 53*)

latter in New Zealand. When we went through the New Moon mine at Bendigo I was greatly impressed with the ability of Hoover to size up and to estimate the ore reserves in a mine after a short visit. On the return trip at Auckland, my wife and I celebrated Christmas at the hotel. Mrs. Hoover was the soul of the gathering, getting together Christmas tree and presents. From that Christmas, I still preserve a hard wood knife, elaborately carved by the cannibals of the New Hebrides.

Many years have passed since then but I still cherish these old memories and the opportunity I had to know Herbert Hoover in the earlier years of his career, which has now culminated in his being elected the President of our country.

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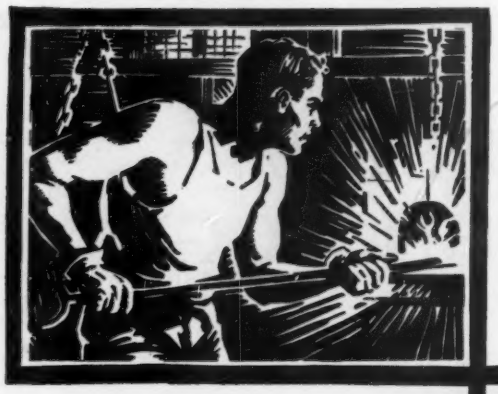

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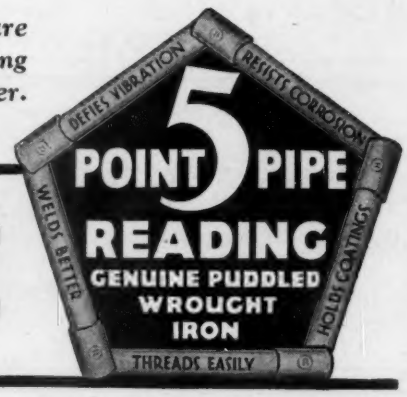

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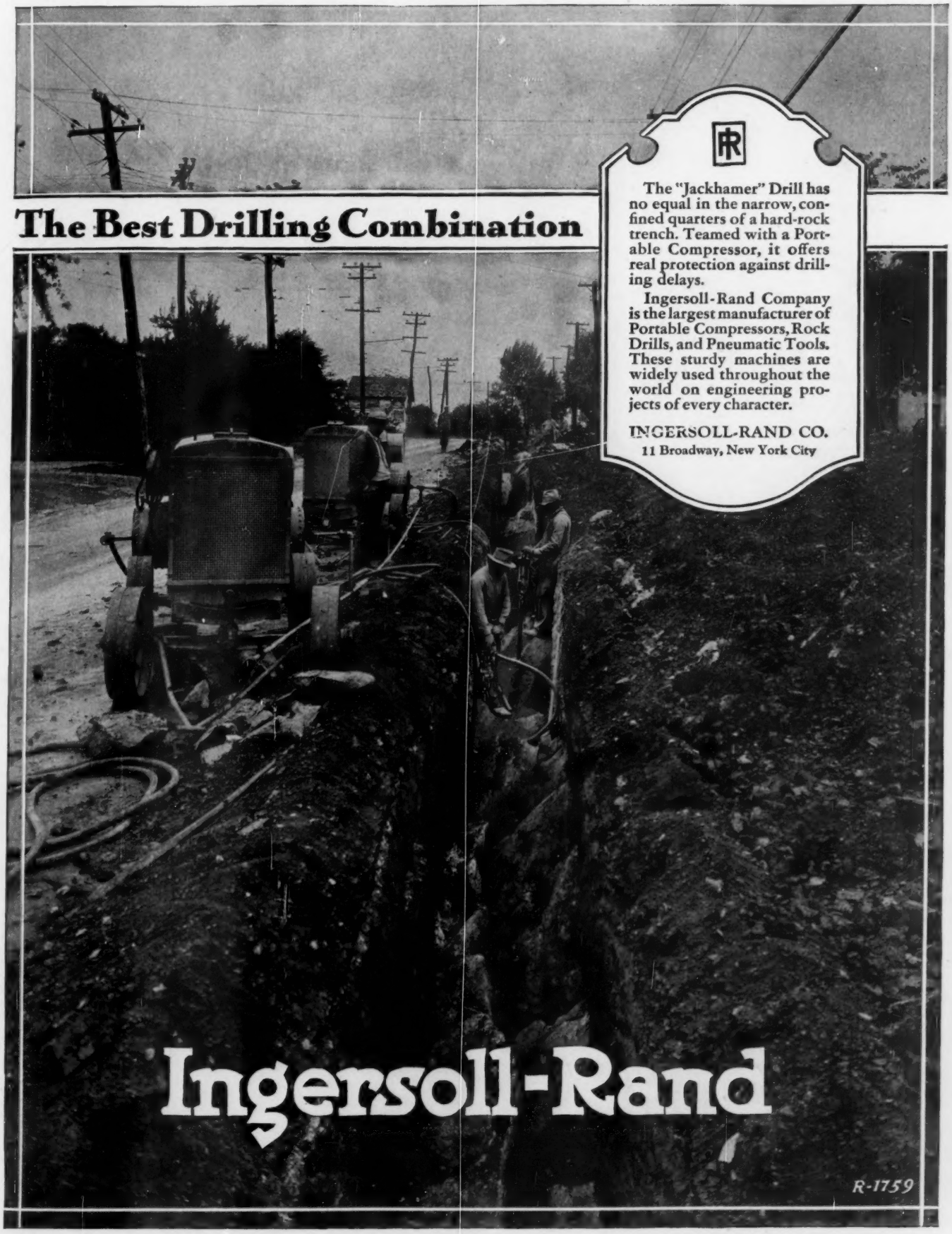

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